TOPIC WISE MULTIPLE CHOICE QUESTIONS

2.1: BASIC CONCEPT OF VECTORS

(1) Name the quantity which is a vector **(GRW 2014)**

(a) Speed **(b)** Force
(c) Temperature **(d)** Density

(2) The direction of vector in space is specified by: **LHR 2015 (G-II)**

(a) 1 – Angle **(b)** 2 – Angles
(c) 3 – Angles **(d)** 4 – Angles

(3) If $\vec{A} = 2\hat{i} + \hat{j} + 2\hat{k}$ then $|A|$ is: **LHR-2016 (G-II)**

(a) zero **(b)** 3
(c) 5 **(d)** 9

(4) If $|a+b| = |a-b|$ then angle between $\vec{a}$ and $\vec{b}$ is **LHR-2017 (G-I)**

(a) 0° **(b)** 45°
(c) 90° **(d)** 180°

(5) Maximum number of components of a vector may be **LHR-2018 (G-II)**

(a) one **(b)** two
(c) three **(d)** infinite

(6) The magnitude of a vector $\vec{r} = 3\hat{i} + 6\hat{j} + 2\hat{k}$ is **LHR-2018 (G-I)**

(a) –1 **(b)** –7
(c) 7 **(d)** 8

(7) If the resultant of two vectors each of magnitude 'F' is also of magnitude 'F' then the angle between them will be: **GRW-2019 (G-I)**

(a) 30° **(b)** 60°
(c) 90° **(d)** 120°

(8) $|\hat{i} - \hat{j} - 3\hat{k}| =$ **(RWP 2012)**

(a) $\sqrt{5}$ **(b)** $\sqrt{7}$
(c) $\sqrt{11}$ **(d)** $\sqrt{13}$

(9) $\vec{A} + \vec{B} = \vec{B} + \vec{A}$, this shows that addition of vectors is **(BWP 2012)**

(a) Associative **(b)** Commutative
(c) Additive **(d)** Additive Inverse

(10) Unit vector of a given vector $\vec{A} = 4\hat{i} + 3\hat{j}$ is: **MTN-2019 (G-I)**

(a) $\frac{4\hat{i}+3\hat{j}}{25}$ **(b)** 1
(c) $\frac{4\hat{i}+3\hat{j}}{5}$ **(d)** $\sqrt{\frac{4\hat{i}+3\hat{j}}{5}}$

(11) A scalar is a physical quantity which is completely specified by
(a) a number only **(b)** Direction only
(c) A number with proper units **(d)** None of these

(12) Another name of rectangular co-ordinate system is
(a) vector system **(b)** physical co-ordinate system
(c) Cartesian co-ordinate system **(d)** Cartesian ordinate system

(13) A unit vector is obtained by dividing the vector with
(a) its direction **(b)** Its magnitude
(c) Itself **(d)** Any scalar quantity

(14) Two vectors are said to be equal if
(a) they have equal magnitude **(b)** they have same direction
(c) both a & b **(d)** they have opposite direction

(15) Number of angles required to represent the direction of vector in space are
(a) one **(b)** two
(c) three **(d)** four

(16) The vector of zero magnitude and arbitrary direction is called
(a) equal vector **(b)** null vector
(c) unit vector **(d)** resultant vector

(17) The maximum number of components of a resultant vector are
(a) two **(b)** three
(c) infinite **(d)** one

(18) If a vector $\vec{A}$ is multiplied by negative number (n < 0) then its direction is changed by:
(a) 0° **(b)** 90°
(c) 60° **(d)** 180°

(19) The unit vector of $\vec{A} = \hat{i} + \hat{j} + \hat{k}$ is
(a) $\vec{A}$ **(b)** $\frac{1}{\sqrt{3}}$
(c) $\frac{(\hat{i} + \hat{j} + \hat{k})}{\sqrt{3}}$ **(d)** zero

(20) If $\vec{A} = 2i + 3\hat{j} - 4\hat{k}$ then magnitude of $\vec{A}$
(a) $\sqrt{-3}$ **(b)** $\sqrt{-1}$
(c) $\sqrt{29}$ **(d)** –1

(21) The minimum number of components of a resultant vector are
(a) 1 **(b)** 2
(c) 3 **(d)** none of these

(22) The position vector $\vec{r}$ of a point p (-1, 2, -3) is given by:
(a) $2\hat{i} - 3\hat{j} + 4\hat{k}$ **(b)** $-2\hat{i} - 3\hat{j} + 4\hat{k}$
(c) $-\hat{i} + 2\hat{i} - 3\hat{k}$ **(d)** none of these

(23) By using head to tail rule we can
(a) add the vectors **(b)** subtract the vectors
(c) multiply the vectors **(d)** both add and subtract the vectors

(24) Which of the given vector is a unit vector?

(a) $\hat{i}$ **(b)** $\hat{i}+\hat{j}$
(c) $\hat{i}+\hat{j}+\hat{k}$ **(d)** all are unit vectors

(25) Parallel vectors must have same

(a) magnitude **(b)** direction
(c) both magnitude and direction **(d)** same magnitude but opposite direction

(26) Which process is not possible for two vectors?

(a) addition **(b)** subtraction
(c) division **(d)** multiplication

(27) When a number is multiplied with a vector, only its direction is reversed if the number is

(a) 1 **(b)** –1
(c) –0.5 **(d)** –2

(28) The resultant of two forces of magnitude 5N each, has also magnitude of 5N, the angle between the forces is

(a) 0^o **(b)** 90^o
(c) 120^o **(d)** 180^o

(29) The vector which describe the location of a point w.r.t the origin is called

(a) parallel vector **(b)** unit vector
(c) null vector **(d)** position vector

(30) The relation $\vec{A}+(-\vec{A})$ results the

(a) parallel vector **(b)** unit vector
(c) null vector **(d)** position vector

(31) The vector subtraction is similar to vector

(a) addition **(b)** division
(c) multiplication **(d)** all of these

(32) A vector which has the same effect as all the original vectors taken together is called:

(a) Position vector **(b)** null vector
(c) equal vector **(d)** resultant vector

(33) The reverse process of addition of vectors is called

(a) negative of a vector **(b)** multiplication of a vector
(c) subtraction of vector **(d)** resolution of a vector

(34) The unit vector is expressed as

(a) $A=|\vec{A}|\times\vec{A}$ **(b)** $A=\frac{\vec{A}}{A}$
(c) $A=\vec{A}A\,A$ **(d)** $A=\vec{A}\times\vec{A}$

(35) The sum of a vector with its negative vector results into

(a) zero vetor **(b)** null vector
(c) both a and b **(d)** none of these

(36) The minimum number of coplanar forces of equal magnitude whose vector sum can be zero, are

(a) 3 **(b)** 2
(c) 1 **(d)** 4

(37) $\vec{r}=a\hat{i}+b\,j+c\,k$

(a) equal vector **(b)** position vector
(c) Unit vector **(d)** negative vector

(38) **The position vector is a vector that describes**
(a) location of a point **(b)** location of magnitude
(c) location of null vector **(d)** none of these

(39) **The vector having magnitude one is called**
(a) null vector **(b)** negative vector
(c) unit vector **(d)** position vector

(40) **If $\vec{A} = 2\hat{i} + \hat{j} + 2\hat{k}$, then $|\vec{A}|$ is**
(a) zero **(b)** 5
(c) 9 **(d)** 3

2.2 VECTOR ADDITION BY RECTANGULAR COMPONENTS

(41) **If rectangular components of a vector has opposite signs, then vector lies in quadrant.**
(a) either in 1^{st} or in 2^{nd} **(b)** either in 2^{nd} or in 4^{th}
(c) 3^{rd} **(d)** 4th

(42) **If a force of 10N is acting along x-axis then its component along y-axis is:** **GRW-2019 (G-II)**
(a) zero **(b)** 5N
(c) 10N **(d)** 15N

(43) **If R_x and R_y both are negative then resultant lies in the quadrant:** **LHR-2019 (G-II)**
(a) 1^{st} **(b)** 2^{nd}
(c) 3^{rd} **(d)** 4^{th}

(44) **The magnitude of rectangular components are equal if its angle with x-axis is:** **(FSD 2012)**
(a) 30^o **(b)** 45^o
(c) 60^o **(d)** 90^o

(45) **If both components of a resultant vector are negative, then resultant lies in** **FSD-2018**
(a) 1^{st} quadrant **(b)** 2^{nd} quadrant
(c) 3^{rd} quadrant **(d)** 4^{th} quadrant

(46) **Rectangular components have angle between them is:** **FSD 2019 (G-I)**
(a) 30° **(b)** 45°
(c) 60° **(d)** 90°

(47) **If A_x and A_y both are negative, the resultant vector will lie in:** **(DGK 2015)**
(a) First quadrant **(b)** Second quadrant
(c) Third quadrant **(d)** Fourth quadrant

(48) **A force of 10 N makes an angle of 30° with x-axis. The magnitude of x-component will be** **MTN-2019 (G-II)**
(a) 5N **(b)** 8.66
(c) 10N **(d)** zero

(49) **Two forces of magnitude 10N each. Their resultant is equal to 20N. Then angle between them is:** **MTN-2019 (G-II)**
(a) 180° **(b)** 30°
(c) 90° **(d)** 0°

(50) **The resultant of two forces 3N and 4N making an angle 90^o with each other is**
(a) 1N **(b)** 7N
(c) 5N **(d)** 3.5N

(51) **Vector $\vec{A}$ is along y-axis. Its x-component will be**
(a) A cosθ **(b)** 0
(c) A **(d)** A sinθ

(52) The direction of vector $\vec{R}$ is given by

(a) $\theta = \tan^{-1}(\frac{R_x}{R_x})$ **(b)** $\theta = \tan^{-1}(\frac{R_x}{R_y})$

(c) $\theta = \sin^{-1}(\frac{R_x}{R_y})$ **(d)** $\theta = \tan^{-1}(\frac{R_y}{R_x})$

(53) If R_x is positive and R_y is negative, then the resultant lies in

(a) 1^{st} quadrant **(b)** third quadrant

(c) fourth quadrant **(d)** 2^{nd} quadrant

(54) When a force of 100 N makes an angle of 60^0 with y-axis, its y-component is

(a) 10N **(b)** 5N

(c) 50N **(d)** 15N

(55) If a vector $\vec{A}$ lies in 3^{rd} quadrant then its direction is given by θ =

(a) Φ **(b)** 180°-Φ

(c) 180°+ Φ **(d)** 360°-Φ

(56) If a vector $\vec{A}$ lies in 4^{th} quadrant and make angle of 60° with y-axis its direction is given by θ =

(a) 30° **(b)** 330°

(c) 270° **(d)** none

2.3 PRODUCTS OF TWO VECTORS (SCALAR AND VECTOR PRODUCTS)

(57) $\hat{i} \cdot \hat{i} =$

(a) $\hat{i}$ **(b)** i^2

(c) 1 **(d)** 2

(58) $\bar{B}.\hat{B}$ **is equal to:** **MTN-2019 (G-II)**

(a) B^2 **(b)** 1

(c) Zero **(d)** B

(59) If $\bar{A} \times \bar{B}$ is along y-axis, then $\vec{A}$ and $\vec{B}$ are in: **BWP-2019 (G-I)**

(a) x – y plane **(b)** y – z plane

(c) Space **(d)** x – z plane

(60) $(\hat{i} \times \hat{j}) \times \hat{k} + (\hat{j} \times \hat{i}) \times \hat{i}$ **will be** **DGK-2018 (G-II)**

(a) $-\hat{j}$ **(b)** $\hat{j}$

(c) $\hat{i}$ **(d)** $\vec{0}$

(61) If magnitudes of scalar product and vector product are same; then the angle between the two vectors is **DGK-2018 (G-I)**

(a) 30° **(b)** 45°

(c) 60° **(d)** 180°

(62) The cross-product of a vector $\bar{A}$ with itself results: **MTN-2018 (G-II)**

(a) $\vec{A}$ **(b)** A^2

(c) zero **(d)** null vector

(63) If two non zero vectors $\vec{A}$ and $\vec{B}$ are parallel to each other then **MTN 2016 (G-I)**

(a) $\vec{A}.\vec{B} = 0$ **(b)** $\vec{A}.\vec{B} = AB$

(c) $|\vec{A} \times \vec{B}| = AB$ **(d)** $|\vec{A} \times \vec{B}| = \vec{A}.\vec{B}$

(64) $\hat{i}.\left(\hat{j}\times\hat{k}\right)$ **is equal to:** **(MTN 2015)**

(a) 1 **(b)** 2

(c) 0 **(d)** $\hat{k}$

(65) **Cross-product of** $\hat{j}\times \hat{i}$ **is:** **FSD 2019 (G-I)**

(a) zero **(b)** $-\hat{k}$

(c) $\hat{i}$ **(d)** $-\hat{i}$

(66) **The magnitude of** $\hat{i}.\left(\hat{i}\times\hat{k}\right)$ **is equal to** **SGD-2016 (G-II)**

(a) 0 **(b)** 1

(c) -1 **(d)** k

(67) **The cross product,** $\hat{k}\times\hat{j}$ **is equal to** **(RWP 2015)**

(a) $-\hat{i}$ **(b)** $-\hat{j}$

(c) $-\hat{k}$ **(d)** $\hat{i}$

(68) **If** $\vec{A}=4\hat{i},\vec{B}=-4\hat{j}$ **then angle of** $\vec{A}+\vec{B}$ **with X-axis is equal to;** **MIRPUR (AJK) 2015**

(a) 45° **(b)** 135°

(c) 225° **(d)** 315°

(69) **Cross product of** $\hat{j}\times\hat{k}$ **is:** **LHR-2019 (G-II)**

(a) zero **(b)** 1

(c) $\hat{i}$ **(d)** $-\hat{i}$

(70) **If** $\vec{F}=\left(2\hat{i}+4\hat{j}\right)N;\vec{d}=\left(5\hat{i}+2\hat{j}\right)m$ **work done is:** **LHR-2019 (G-I)**

(a) 15 J **(b)** 18 J

(c) zero **(d)** –18 J

(71) **If AB sinθ = AB cosθ then the angle between** $\vec{A}$ and $\vec{B}$ **is:** **GRW-2019 (G-I)**

(a) 30° **(b)** 45°

(c) 60° **(d)** 180°

(72) $\left(\hat{k}\times\hat{k}\right)$ **is equal to:** **LHR-2018 (G-II)**

(a) $\hat{k}$ **(b)** 1

(c) null vector **(d)** zero

(73) **The magnitude of** $\hat{i}.(\hat{j}\times\hat{j})$ **is equal to:** **LHR 2015(G-I)**

(a) 0 **(b)** 1

(c) –1 **(d)** $\hat{i}$

(74) $\left|\vec{\mathbf{A}}\times\vec{\mathbf{B}}\right|=$

(a) AB cosθ **(b)** ABsinθn

(c) AB sinθ **(d)** none

(75) **Scalar product of two vectors** $\vec{\mathbf{A}}$ **and** $\vec{\mathbf{B}}$ **is defined as:**

(a) AB sin θ **(b)** AB tan θ

(c) AB **(d)** AB cos θ

(76) **What is angle between the given two vectors $\hat{i}+\hat{j}$ and $\hat{i}-\hat{j}$**
(a) 0^o **(b)** 30^o
(c) 45^o **(d)** 90^o

(77) **The scalar product of two vectors $\vec{A}$ and $\vec{B}$ results in**
(a) vector quantity **(b)** scalar quantity
(c) linear quantity **(d)** none of these

(78) **Vector product of two vectors A and B is defined as**
(a) AB sin θ **(b)** AB sin θ **n**
(c) AB cosθ **n** **(d)** both 'a' and 'b'

(79) **By increasing the value of angle $(0^o < \theta < 90^o)$ between the two given vectors their cross product in magnitude**
(a) increases **(b)** decrease
(c) remain same **(d)** may increase or decrease

(80) **At which angle between two vectors, their scalar product is equal to half of the product of their magnitude**
(a) 30^o **(b)** 45^o
(c) 60^o **(d)** 80^o

(81) **Which Product of two vectors is commutative?**
(a) cross **(b)** scalar
(c) both 'a' and 'b' **(d)** none of these

(82) **If $\vec{A}$ and $\vec{B}$ are two parallel vectors then which one is not correct**
(a) **A.B = 0** **(b)** $\mathbf{A}\times\mathbf{B}=\vec{0}$
(c) $\vec{A}\times\vec{B}=\vec{0}$ **(d)** $\vec{A}\cdot\vec{B}=AB$

(83) **Two forces act together on an object the magnitude of their resultant force is minimum when angle between them is**
(a) 0^o **(b)** 45^o
(c) 90^o **(d)** 180^o

(84) **If $\vec{A}\cdot\vec{B}$ =0, then**
(a) $\vec{A}$ is parallel to $\vec{B}$ **(b)** $\vec{A}$ is anti-parallel to $\vec{B}$
(c) $\vec{A}$ is perpendicular to $\vec{B}$ **(d)** all of these

(85) $\hat{k}\times\hat{k}=$
(a) 1 **(b)** zero
(c) k^2 **(d)** null vector

(86) **Three vectors of equal magnitude are added and magnitude of their resultant is zero. The angle between any of two vectors is**
(a) 30^o **(b)** 60^o
(c) 90^o **(d)** 120^o

(87) **Force is equal to product of mass and acceleration, the product is called**
(a) scalar product **(b)** vector product
(c) simple product **(d)** none

(88) **Vector A is making angle θ with y-axis its rectangular components have magnitude**
(a) A_x = A sinθ, A_y =A cosθ **(b)** A_x = A cosθ, A_y =A sinθ
(c) A_x=A tanθ, A_y = A cotθ **(d)** A_x= A cotθ, A_y = A tanθ

(89) $\hat{\mathbf{j}}.\hat{\mathbf{i}} =$
(a) 1 **(b)** zero
(c) **k** (d) **−k**

(90) **If the dot product is negative, then angle between the vectors is**
(a) 0° **(b)** 90°
(c) 180° **(d)** 270°

(91) **The vector product of two vectors $\vec{A}$ and $\vec{B}$ is vector $\vec{C}$ whose magnitude is given by**
(a) $C = AB\sin\theta$ **(b)** $C = AB\cos(90-\theta)$
(c) $\vec{C} = \vec{A}.\vec{B}\cos\theta$ **(d)** both a and b

(92) **Self dot product of a vector A is equal to**
(a) A **(b)** A^2
(c) $A^2/2$ **(d)** none of these

(93) **If** $|\vec{A}\times\vec{B}| = |\vec{A}.\vec{B}|$ **then angle between the vectors is**
(a) 0^o **(b)** 90^o
(c) 180^o **(d)** 45^0

(94) **Cross-product of two parallel vectors is:**
(a) Maximum **(b)** negative
(c) zero **(d)** null vector

(95) **Which relation is incorrect?**
(a) $\vec{\tau} = \vec{r}\times\vec{F}$ **(b)** $\vec{F} = q(\vec{v}\times\vec{B})$
(c) $P = \vec{F}\times\vec{v}$ **(d)** $\vec{L} = \vec{r}\times\vec{p}$

(96) $\vec{\mathbf{A}}.\mathbf{A}$ **is equal to**
(a) 1 **(b)** zero
(c) A **(d)** A Cosθ

(97) **If $\vec{\mathbf{A}} = \vec{\mathbf{B}}$ then which equation is not correct**
(a) $\mathbf{A}.\mathbf{B} = AB$ **(b)** $\mathbf{A} = \mathbf{B}$
(c) A = B **(d)** all are correct

(98) **Which of the following is a scalar product?**
(a) torque **(b)** work
(c) power **(d)** both work and power

(99) **Scalar projection of vector $\vec{\mathbf{B}}$ on $\vec{\mathbf{A}}$ is written as**
(a) B cosθ **(b)** A cosθ
(c) AB cosθ **(d)** A sinθ

(100) $(\hat{\mathbf{i}}\,x\,\hat{\mathbf{j}}) + (\hat{\mathbf{j}}\,x\,\mathbf{k})$ **is equal to**
(a) 1 **(b)** null vector
(c) zero **(d)** $\hat{\mathbf{i}} + \mathbf{k}$

(101) **Self cross product of a unit vector is equal to**
(a) zero **(b)** null vector
(c) one **(d)** negative

(102) **Which one is correct**
(a) $\vec{\mathbf{A}}.\vec{\mathbf{B}} = -\vec{\mathbf{A}}.\vec{\mathbf{B}}$ **(b)** $\vec{\mathbf{A}}\times\vec{\mathbf{B}} \neq \vec{\mathbf{B}}\times\vec{\mathbf{A}}$
(c) $\vec{\mathbf{A}}\times\vec{\mathbf{B}} = \vec{\mathbf{B}}\times\vec{\mathbf{A}}$ **(d)** none of these

(103) Area of parallelogram whose adjacent sides are $\vec{A}$ and $\vec{B}$ is given by

(a) zero **(b)** AB cos θ

(c) AB sin θ **(d)** AB

(104) The cross product $\hat{i}\times\hat{j}$ is

(a) 1 **(b)** 0

(c) k **(d)** -k

(105) Which condition could make $\vec{A}\times\vec{B}=\vec{O}$

(a) both vectors are parallel or anti-parallel **(b)** vector $\vec{B}$ is a null vector

(c) vector $\vec{A}$ is null vector **(d)** all of these

(106) At which angle the scalar product could be negative

(a) 60^o **(b)** 90^o

(c) 180^o **(d)** 45^o

(107) At what angle the dot product will be half of its magnitude

(a) 0^o **(b)** 90^o

(c) 60^o **(d)** 45^o

(108) The $\hat{i}.k$ is equal to

(a) zero **(b)** 1

(c) $-\hat{j}$ **(d)** $\hat{j}$

(109) The position vector of point P(x,y) can be written as

(a) $\vec{r}=x\hat{i}+y\hat{j}$ **(b)** $\vec{r}=x\hat{j}+y\hat{i}$

(c) $\vec{r}=x\hat{j}+0\hat{i}$ **(d)** none of these

(110) If $\vec{F_1}=3\hat{i}+2\hat{j}$ and $\vec{F}_2=2\hat{i}+3\hat{j}$ then $\vec{F}_1.\vec{F}_2$ will be

(a) 24 **(b)** 12

(c) 6 **(d)** 0

(111) Which property does not hold for vector product

(a) associative property **(b)** commutative property

(c) distributive property over addition **(d)** none of these

(112) The expression $\dfrac{A_xB_x+A_yB_y+A_zB_z}{AB}$ is equal to

(a) cosθ **(b)** sinθ

(c) tanθ **(d)** projection of $\vec{A}$ on $\vec{B}$

(113) $\vec{A}.\vec{A}$ is equal to

(a) zero **(b)** one

(c) A **(d)** A^2

(114) $(\hat{i}\times\hat{j})+(\hat{j}\times\hat{i})$

(a) 1 **(b)** null vector

(c) −1 **(d)** i^2

(115) For the two perpendicular vectors, cross product has value

(a) maximum **(b)** minimum

(c) zero **(d)** none of these

(116) If two non-zero vectors $\vec{a}$ and $\vec{b}$ are parallel to each other, then
(a) $\vec{a}.\vec{b} = 0$
(b) $\vec{a}.\vec{b} = ab$
(c) $|\vec{a}\times\vec{b}| = \vec{a}.\vec{b}$
(d) none of these

(117) $\vec{A}\times\vec{B}$ is along Z-axis. Then two vector $\vec{A}$ and $\vec{B}$ lie in
(a) xz-plane
(b) yz-plane
(c) xy-plane
(d) in three dimensional space

(118) The magnitude of $\vec{A}\times\vec{B}$ is equal to the
(a) area of triangle
(b) area of sphere
(c) area of parallelogram
(d) area of circle

(119) Consider a vector $4\hat{i} - 3\hat{j}$, another vector that is perpendicular to it is
(a) 4i + 3j
(b) 6i
(c) 3i – 4j
(d) 7k

(120) The resultant of two forces 3N and 4N making an angle 0^o with each other is
(a) 1N
(b) 7N
(c) 5N
(d) 3.5N

(121) The dot product $\hat{i}.\hat{i} = j.j = k.k$ is equal to
(a) 0
(b) 1
(c) –1
(d) $\hat{i}$

(122) The scalar product of two vectors is maximum when they are
(a) Parallel
(b) Perpendicular
(c) Anti-parallel
(d) Null

2.4 TORQUE

(123) Turning effect of force is called
(a) moment of force
(b) momentum
(c) torque
(d) both a and c

(124) Dimension of torque is
(a) $[ML^2T^{-1}]$
(b) $[ML^{+2}T^{-2}]$
(c) $[ML^{-1}T^2]$
(d) $[ML^{-2}T^{-2}]$

(125) Torque ($\vec{\tau}$) is defined as
(a) **r × F**
(b) **F × r**
(c) Fr cosθ
(d) rF tanθ

(126) Conventionally, clockwise torque is taken as
(a) zero
(b) negative
(c) positive
(d) none of these

(127) Torque has maximum value if angle between $\vec{r}$ and $\vec{F}$ is
(a) 30^o
(b) 90^o
(c) 45^o
(d) 60^o

(128) The perpendicular distance from the axis of rotation to the line of action of force is called
(a) momentum
(b) moment arm
(c) torque
(d) center of gravity

(129) A body cannot rotate about its center of gravity under the action of its weight because
(a) momentum is zero
(b) moment arm is zero
(c) moment arm is maximum
(d) turning effect is maximum

(130) The moment of force is defined as $\vec{\tau} = \vec{r} \times \vec{F}$ where $\bar{r}$ is

(a) position vector w.r.t pivot point **(b)** Couple arm

(c) radius vector **(d)** momentum arm

(131) The SI unit of torque is

(a) joule **(b)** N m

(c) N s **(d)** J s

(132) If the body is rotating with uniform angular velocity then torque acting on body is

(a) Maximum **(b)** minimum

(c) zero **(d)** negative

(133) When the line of action of the applied force passes through the pivot point, the value of moment arm will be

(a) maximum **(b)** zero

(c) minimum **(d)** none of these

(134) The torque acting on a body determines its

(a) angular velocity **(b)** angular displacement

(c) force **(d)** angular acceleration

(135) Torque is analogous of

(a) force for rotational motion **(b)** force for linear motion

(c) angular velocity **(d)** angular momentum

ANSWER KEYS

(Topic Wise Multiple Choice Questions)

1	b	16	b	31	a	46	d	61	b	76	d	91	d	106	c	121	b
2	c	17	a	32	d	47	c	62	d	77	b	92	b	107	c	122	a
3	b	18	d	33	d	48	b	63	b	78	b	93	d	108	a	123	d
4	c	19	c	34	b	49	d	64	a	79	a	94	c	109	a	124	b
5	d	20	c	35	b	50	c	65	c	80	c	95	c	110	b	125	a
6	c	21	c	36	b	51	b	66	b	81	b	96	c	111	b	126	b
7	d	22	c	37	b	52	d	67	a	82	a	97	d	112	a	127	b
8	c	23	d	38	a	53	c	68	d	83	d	98	d	113	d	128	b
9	b	24	a	39	c	54	c	69	c	84	c	99	a	114	b	129	b
10	c	25	c	40	d	55	c	70	b	85	d	100	d	115	a	130	a
11	c	26	c	41	b	56	b	71	b	86	d	101	b	116	b	131	b
12	c	27	b	42	a	57	c	72	b	87	c	102	b	117	c	132	c
13	b	28	c	43	c	58	d	73	b	88	a	103	c	118	c	133	b
14	c	29	d	44	b	59	d	74	c	89	b	104	c	119	d	134	d
15	c	30	c	45	c	60	a	75	d	90	c	105	d	120	b	135	b

SHORT QUESTIONS

(From Textbook Exercise)

2.1. Define the terms (i) Unit vector (ii) Position vector and (iii) Components of a vector.

SGD-15(G-II), MTN-15(G-I), SGD-16(G-I) & (G-II), LHR-17 (G-I) & (G-II), SWL-19

Ans: (i) Unit Vector

A unit vector in a given direction is a vector with magnitude one in that direction. It is used to represent the direction of a vector. A unit vector in the direction of $\vec{A}$ is written as $\hat{A}$, which we read as 'A hat 'Thus

$$\vec{A} = A\hat{A} \qquad \hat{A} = \frac{\vec{A}}{A} \qquad OR \qquad \hat{A} = \frac{A_x\hat{i} + A_y\hat{j} + A_z\hat{k}}{\sqrt{A_x^2 + A_y^2 + A_z^2}}$$

Examples of unit vectors are:

(i) $\hat{i}$ is unit vector along x-axis

(ii) $\hat{j}$ is unit vector along y-axis.

(iii) $\hat{k}$ is unit vector along z-axis.

(iv) $\hat{n}$ is unit vector which may have any direction.

(ii) Position Vector

It is a vector that describes the location of a point with respect to the origin. It is represented by a straight line drawn in such a way that its tail coincides with the origin and the head with point P.

- Position vector of point P (a, b) in a plane is written as $\vec{r} = a\hat{i} + b\hat{j}$ and $r = \sqrt{a^2 + b^2}$ as in figure (i).

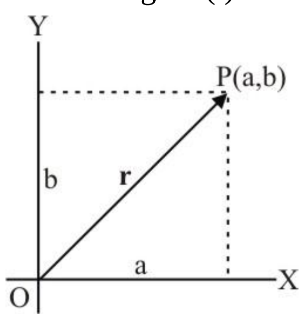


Fig (i)

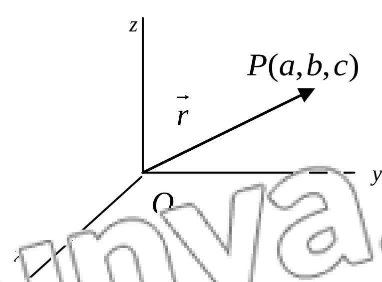


Fig (ii)

- Position vector $\vec{r}$ of point (a, b, c) in space has positions a, b and c on x, y and z axes respectively which are known as rectangular components of vector r as shown in fig (ii).

$$\vec{r} = a\hat{i} + b\hat{j} + c\hat{k} \quad \text{and} \quad r = \sqrt{a^2 + b^2 + c^2}.$$

(iii) Components of a Vector

A component of a vector is its effective value in a given direction. A vector may be considered as the resultant of its component vectors along the specified directions.

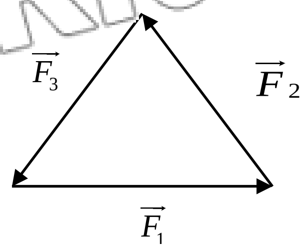
2.2. The vector sum of three vectors gives a zero resultant. What can be the orientation of the vectors?

FSD-14(G-I), FSD-15(G-I), SGD-15(G-I), GRW-15(G-I), DGK-16 (G-I), BWP-16 (G-I), SGD-16 (G-II), LHR-18 (G-I)

Ans: When the three vectors $\vec{F}_1, \vec{F}_2$ and $\vec{F}_3$ are arranged in such a way that they form a triangle, then their resultant is zero. When head of $\vec{F}_3$ coincides with tail of $\vec{F}_1$, then resultant becomes zero.

So, we can write

$\vec{R} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 = 0$



2.9. Is it possible to add a vector quantity to a scalar quantity? Explain.

RWP-16 (G-I), LHR-16 (G-II), BWP-17 (G-I), SWL-19, GRW-19 (G-II), MTN-19 (G-II)

Ans: No, a vector quantity cannot be added to a scalar quantity.

By the rule of vector addition, only similar physical quantities can be added, whereas vectors and scalar are not similar physical quantities. Vectors possess, both magnitude and direction and scalars have only magnitude, thus these cannot be added.

2.10. Can you add zero to a null vector?

MTN-15(G-I), BWP-15(G-I), SGD-15(G-II), RWP-15(G-I), LHR-15(G-I), MIRPUR (AJK) 15, LHR-17 (G-II)

Ans: No, a vector quantity cannot be added to a scalar quantity. Null vector is a vector with zero magnitude but simple zero is a scalar. As scalar cannot be added to vector, therefore we cannot add zero to a null vector.

2.12. Show that the sum and difference of two perpendicular vectors of equal lengths are also perpendicular and of the same length.

DGK-15(G-I), BWP-15(G-I), BWP-17 (G-I)

Ans: As $|\vec{A}| = |\vec{B}|$ and $\vec{R} = \vec{A} + \vec{B}$ and $\vec{R}' = \vec{A} - \vec{B}$ as shown in figure.

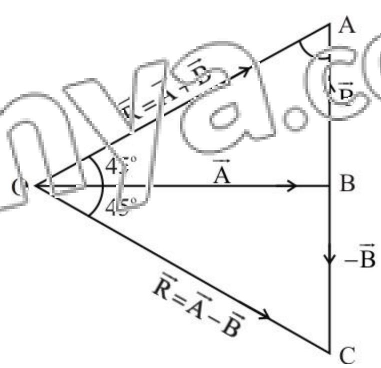
Angle between $\vec{A}$ and $\vec{B} = 90^o$

In right angled triangle Δ AOB

$\angle AOB = 45^o$

In right angled triangle Δ BOC

$\angle BOC = 45^o$



` $\angle AOC = \angle AOB + \angle BOC = 45^o + 45^o = 90^o$

So OA is perpendicular to OC

Now $|\vec{R}| = \sqrt{A^2 + (-B)^2}$

$|\vec{R}'| = \sqrt{A^2 + B^2}$

So the magnitude of $(\vec{A} + \vec{B})$ & $(\vec{A} - \vec{B})$ are equal and perpendicular to each other

2.13. How would the two vectors of the same magnitude have to be oriented, if they were to be combined to give a resultant equal to a vector of the same magnitude.

MTN-15(G-I), FDR-15, SWL-19

Ans: The two vectors to be combined to give a resultant equal to a vector of the same magnitude if they were oriented at an angle of 120^o.

Proof: The magnitude of resultant of two vectors $\vec{A}$ and $\vec{B}$

$$R=\sqrt{A^2+B^2+2AB\cos\theta}$$

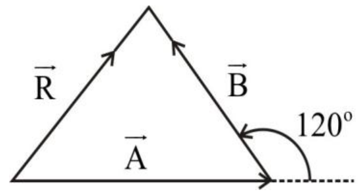
If R = A = B = F

$F^2 = F^2 + F^2 + 2F^2 \cos\theta$

$1 = 1 + 1 + 2\cos\theta$

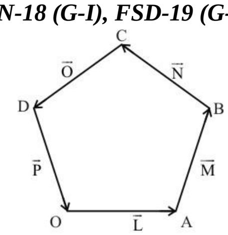
$2\cos\theta = -1$

$$\cos\theta=\frac{-1}{2} \quad \text{or} \quad \theta=\cos^{-1}\left(-\frac{1}{2}\right)=120°$$



2.15. Suppose the sides of a closed polygon represent vector arranged head to tail. What is the sum of these vectors? ***MTN-18 (G-I), FSD-19 (G-I)***

Ans: Vectors $\vec{L},\vec{M},\vec{N},\vec{O},\vec{P}$ are represented by the sides OA, AB, BC, CD, DO, of a closed polygon. If the sides of the closed polygon represent the vectors arranged by head to tail rules then $\vec{R}=\vec{L}+\vec{M}+\vec{N}+\vec{O}+\vec{P}=0$ i.e Resultant is zero.



2.16. Identify the correct answer.

(i) Two ships X and Y are traveling in different directions at equal speeds. The actual direction of motion of X is due north but to an observe on Y, the apparent direction of motion of X is north-east. The actual direction of motion of Y as observed from the shore will be

(a) East (b) West (c) South – east (d) South – west

Ans: **(i)** Given directions of motion of two ships are shown in fig (a). Fig (b) shows that actual direction of motion of Y i.e $\vec{V}_y$ is towards west.

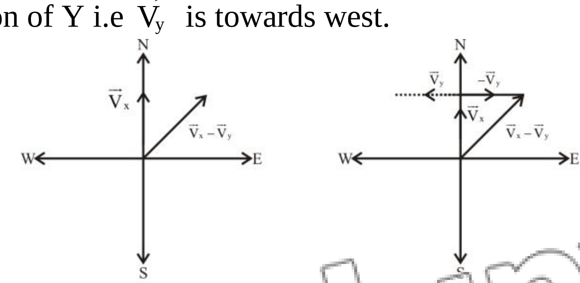


Fig (a) Fig (b)

(ii) A horizontal force F is applied to a small object P of mass m at rest on a smooth plane inclined at an angle θ to the horizontal as shown in Fig. 2.22. The magnitude of the resultant force acting up and along the surface of the plane, on the object is

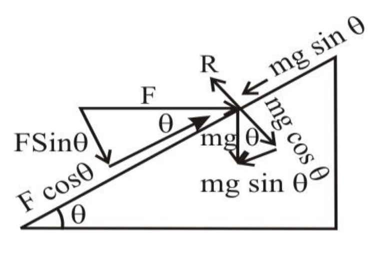
$a) F\cos\theta - mg\sin\theta$

$b) F\sin\theta - mg\cos\theta$

$c) F\cos\theta + mg\cos\theta$

$d) F\sin\theta + mg\sin\theta$

$e) mg\tan\theta$



Ans: **(a)** $F\cos\theta - mg\sin\theta$

2.17. If all the components of the vectors, A_1 and A_2 were reversed, how would this alter $\vec{A}_1 \times \vec{A}_2$? *LHR-13 (G-I)*

Ans: If all the components of the vectors $\vec{A}_1$ *and* $\vec{A}_2$ are reversed, then we get new vectors which are negative of $\vec{A}_1$ *and* $\vec{A}_2$ i.e $\vec{A'}_1 = -\vec{A}_1$ *and* $\vec{A'}_2 = -\vec{A}_2$

Now $\vec{A'}_1 \times \vec{A'}_2 = (-\vec{A}_1) \times (-\vec{A}_2)$

$= \vec{A}_1 \times \vec{A}_2$

It shows that $\vec{A}_1 \times \vec{A}_2$ will not alter.

TOPIC WISE SHORT QUESTIONS

2.1 BASIC CONCEPTS OF VECTORS

(1) How can we express the magnitude of a vector?

Ans: Symbolically, the magnitude of a vector can be represented by light face letter e.g A, d, r, etc. Graphically, the magnitude of a vector can be measured by length of a vector according to selected scale.

(2) What is meant by Null vector?

Ans: A vector whose magnitude is zero and has an arbitrary direction is called Null vector. It is represented by $\vec{O}$.

We can obtain the null vector by adding a vector into its negative vector.

$$\vec{A} + \left(-\vec{A}\right) = \vec{0}$$

(3) If force of magnitude 20N makes an angle of 30^o with x - axis then find its y - component?

Ans: F = 20N

$\theta = 30^o$

F_y =?

$F_y = F \sin\theta$

$= 20 \sin 30^o$

$= 20\left(\frac{1}{2}\right)$

$F_y = 10N$

(4) If force $\vec{F}$ of magnitude 10N makes an angle of 30^o with y-axis then find its x-component.

Ans: F = 10N

Angle of $\vec{F}$ with x-axis

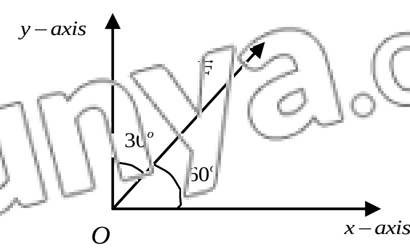
$\theta = 90^o - 30^o = 60^o$

F_x =?

$F_x = F \cos\theta$

$= 10 \cos (60^o)$

$= 10\left(\frac{1}{2}\right) = 5N$



(5) What is negative of a vector? How a vector $\vec{B}$ is subtracted from a vector $\vec{A}$? **LHR-2012**

Ans: When a given vector is multiplied by a number such that n < 0 then new vector will be known as negative vector of given vector. In vector subtraction, actually, the negative vector of one vector is added with other vector. If vector $\vec{B}$ is to be subtracted from a vector $\vec{A}$, then it can be done by taking the negative of vector $\vec{B}$ and adding it in vector $\vec{A}$. Resultant vector according to head to tail rule gives the difference $\vec{A}-\vec{B}$.

Note: Vectors subtraction is not commutative. i.e. $\vec{A}-\vec{B} \neq \vec{B}-\vec{A}$

(6) Find the unit vector of the vector $\vec{A}=4\hat{i}+3\hat{j}$. **LHR-2012**

Ans: As we know that:

$\hat{A}=\frac{\vec{A}}{A}$ where A is magnitude of given vector.

$A=\sqrt{A_x^2+A_y^2}$

$A=\sqrt{4^2+3^2}$

$A=\sqrt{16+9}$

$A=\sqrt{25}=5$

Therefore: $\hat{A}=\frac{\vec{A}}{A}=\frac{4\hat{i}+3\hat{j}}{5}$

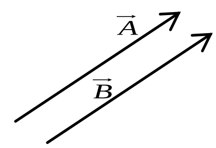
(7) Define Null Vectors, Equal Vectors. **LHR-2014**

Ans: Null Vector:

Null vector is a vector of zero magnitude and arbitrary direction. For example, the sum of a vector and its negative vector is a null vector. $\vec{A}+\left(-\vec{A}\right)=\vec{0}$

Equal vectors:

Two vectors $\vec{A}$ and $\vec{B}$ are said to be equal if they have the same magnitude and direction, regardless of the position of their initial points.

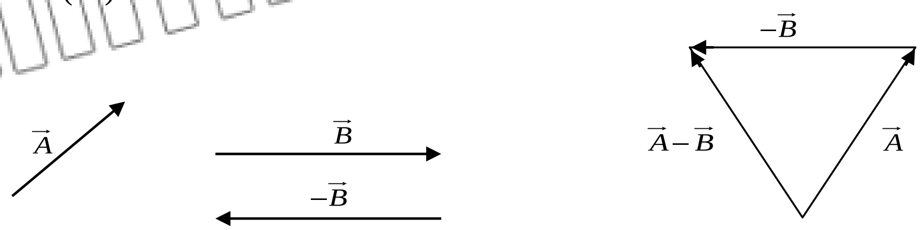


This means that parallel vectors of the same magnitude are equal to each other.

(8) The subtraction of a vector is equivalent to the addition of the same vector, Prove it **GRW-2014**

Ans: The subtraction of a vector is equivalent to the addition of the same vector with its direction reversed. Thus, to subtract vector $\vec{B}$ from vector $\vec{A}$, reverse the direction of $\vec{B}$ and add it to $\vec{A}$ as shown in the diagram given below.

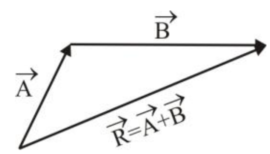
A – B = A + (-B)



(9) How do we add the vectors?

Ans: Addition of vectors:

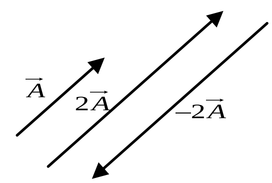
Given two vectors $\vec{A}$ *and* $\vec{B}$. Their sum is obtained by drawing their representative lines in such a way that the tail of vector $\vec{B}$ coincides with the head of vector $\vec{A}$. Now if we join the tail of $\vec{A}$ to the head of $\vec{B}$. This line will represent the vector sum $(\vec{A}+\vec{B})$ in magnitude and direction. The vector sum is called resultant vector and is indicated by $\vec{R}$.



(10) Define the multiplication of a vector by a scalar. **GRW-2015**

Ans: (i) Multiplication by a dimensionless scalar:

When a vector $\vec{A}$ is multiplied by a positive number 'n' the magnitude of the resultant vector $n\vec{A}$ becomes the 'n' times the magnitude of $\vec{A}$, but directions of $n\vec{A}$ remains same as that of $\vec{A}$. If $\vec{A}$ is multiplied by negative number (-n). The magnitude of resultant vector is n times the magnitude of $\vec{A}$ but its direction is opposite to that of $\vec{A}$.



(ii) Multiplication by dimensional scalar:

If n is a scalar quantity and $\vec{A}$ be vector then $n\vec{A}$ will be a new physical quantity having dimensions, equal to the product of the dimensions of n and $\vec{A}$. Example Momentum has dimension equal to product of dimensions of mass and velocity.

(11) Define unit vector. How we find it? **LHR-2016 (G-II)**

Ans: "A vector whose magnitude is one is known as unit vector"

We know that

Vector = magnitude × direction

If magnitude = 1, then

Unit vector = 1 × Direction of a vector

Unit vector = Direction of a vector

This shows that unit vector indicates only the direction of a vector.

Mathematically,

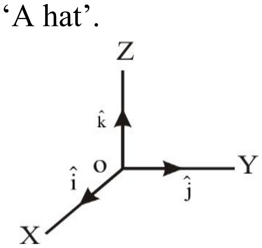
$$\vec{A} = A\hat{A}$$

$$\hat{A} = \frac{\vec{A}}{A}$$

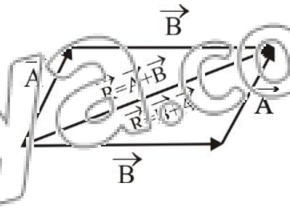
A unit vector in the direction of $\vec{A}$ is written as $\hat{A}$, which we read as 'A hat'.

(12) What is the angle between unit vectors $\hat{i}, \hat{j}$ and $\hat{k}$. What are their orientation.

Ans: The unit vectors $\hat{i}, \hat{j}$ and $\hat{k}$ are mutually perpendicular. So the angle between any two given unit vectors is 90°. The unit vectors $\hat{i}, \hat{j}$ and $\hat{k}$ are usually along x-axis, y – axis and z – axis respectively.



(13) Show that vector addition is commutative?



Ans: When $\vec{A}$ is added to $\vec{B}$ then resultant is $\vec{R}=\vec{A}+\vec{B}$ ------ (i)

when $\vec{B}$ is added to $\vec{A}$ then the resultant is $\vec{R}=\vec{B}+\vec{A}$ ------ (ii)

as shown in fig

So from equation (i) and (ii) it is clear,

$$\vec{A}+\vec{B}=\vec{B}+\vec{A}$$

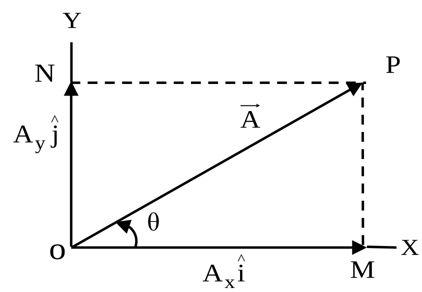
It shows that vector addition is commutative.

(14) If two vectors are parallel and anti-parallel, what will be their resultant vector?

Ans: If two vectors are parallel, then the resultants is maximum and have the magnitude equal to the sum of the magnitudes of the given parallel vectors. If two vectors are anti parallel, the resultant is minimum and have the magnitude equal to the difference of the magnitudes of the given anti parallel vectors.

(15) Describe briefly, how we obtain the vector, when its rectangular components are given? **FSD-2012**

Ans: If the rectangular components of a vector, as shown in Fig. are given, we can find out the magnitude of the vector by using Pythagorean Theorem.



In the right angled Δ OMP.

$$(OP)^2 = (OM)^2 + (MP)^2$$

or $$A^2 = A_x^2 + A_y^2$$

or $$A=\sqrt{A_x^2 + A_y^2}$$

and direction θ is given by

$$tan\theta = \frac{A_y}{A_x}$$

or $$\theta = tan^{-1}\left(\frac{A_y}{A_x}\right)$$

(16) Explain rectangular coordinate system. **FSD-2017**

Ans: Two reference lines drawn at right angles to each other are known as coordinate axes and their point of intersecton is known as origin. This system of coordinate axes is called Cartesian or rectangualr coordiante system.

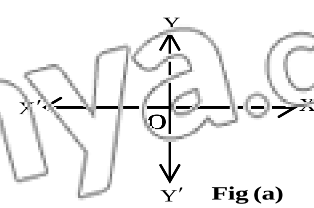


Fig (a)

One of the lines is named as x – axis and other y – axis. Usually the x – axis is taken as horizontal axis. The other line is called y – axis and is taken as a vertical axis. The direction of a vector in a plane is denoted by angle θ which the representative line of the vector makes with positive x-axis in anticlockwise direction as shown in Fig 2.1(b). The point P shown in Fig 2.1 (b) has coordinates (a, b). This notation means that if we start at the origin, we can reach P by moving 'a' units along the positive x-axis and then 'b' units along the positive y-axis.

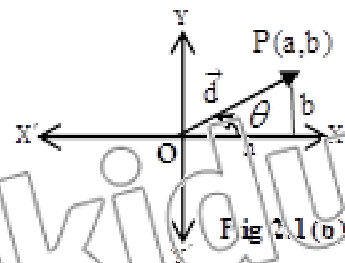


Fig 2.1 (b)

The direction of a vector in space requires another axis which is at right angle to both x and y axes, as shown in Fig 2.2 (a). The third axis is called z-axis.

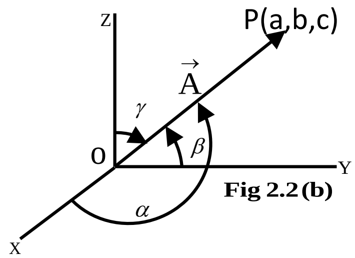


Fig 2.2 (b)

(17) What are rectangular components of a vector? At what angle there components are equal? **MTN-2012**

Ans: Rectangular Components:

The components of a vector which are mutually perpendicular with each other are called rectangular component.

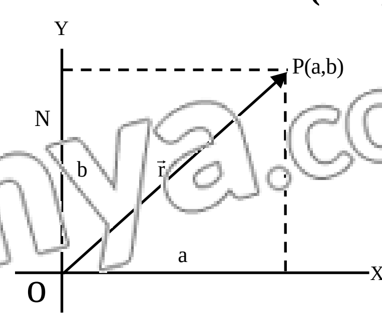
If given vector is making an angle of 45° then its horizontal and vertical components are equal in magnitude.

$$A_x = A\cos\theta = A\cos 45^o = \frac{A}{\sqrt{2}}$$

$$A_y = A\sin\theta = A\sin 45^o = \frac{A}{\sqrt{2}}$$

(18) Define position vector? **DGK-2016 (G-II)**

Ans: The position vector $\vec{r}$ is a vector that describes the location of a point with respect to the origin. It is represented by a straight line drawn in such a way that its tail coincides with the origin and the head with point P (a, b) as shown in Fig. The projections of position vector $\vec{r}$ on the x and y axes are the coordinates a and b and they are the rectangular components of the vector $\vec{r}$.



Hence.

$\vec{r} = a\hat{i} + b\hat{j}$ and $r = \sqrt{a^2 + b^2}$ …………….. (i)

(19) To get sum of two vectors equal to null vector, what are the conditions? GRW-2018

Ans: To get sum of two vectors equal to null vector, following conditions should be satisfied:

(i) Two vectors should be of same magnitude

(ii) One vector should be negative of other vector

For example, the sum of a vector and its negative vector is a null vector.

$\vec{A}+\left(-\vec{A}\right)=\vec{0}$

(20) What is the unit vector in the direction of vector $\vec{A}=2\hat{i}-\hat{j}+2\hat{k}$. LHR-2018 (G-II)

Ans: As we know that:

$\hat{A}=\frac{\vec{A}}{A}$ where A is magnitude of given vector.

$$A=\sqrt{A_x^2+A_y^2+A_z^2}$$

$$A=\sqrt{2^2+1^2+2^2}$$

$$A=\sqrt{4+1+4}$$

$$A=\sqrt{9}=3$$

Therefore: $\hat{A}=\frac{\vec{A}}{A}=\frac{2\hat{i}-\hat{j}+2\hat{k}}{3}$

(21) A force of 10 N makes an angle of 60° with x-axis. Find its x and y-components. SGD-2018 (G-I)

Ans: x, y components of the given vector are given below:

$$A_x=A\cos\theta=10\cos 60^0=10\left(\frac{1}{2}\right)=5N$$

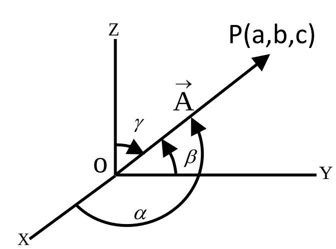
$$A_y=A\sin\theta=10\sin 60^0=10\left(\frac{\sqrt{3}}{2}\right)=5\sqrt{3}N$$

(22) Is it possible to add 5 in $2\hat{i}$? Explain. MTN-2019 (G-I)

Ans: No, a vector quantity cannot be added to a scalar quantity. It is not possible to add 5 in $2\hat{i}$ because 5 is a scalar and $2\hat{i}$ is a vector. Physical quantities of same nature can be added.

(23) How can the direction of a vector be specified in three dimensions? Explain with diagram. MTN-2019 (G-II)

Ans: The direction of a vector in space is specified by the three angles which the representative line of the vector makes with x, y and z axes respectively as shown in Fig. The point P of a vector A is thus denoted by three coordinates (a, b, c).



2.2 VECTOR ADDITOIN BY RECTANGULAR COMPONENTS

(24) How can we add the number of vectors $\vec{A}, \vec{B}, \vec{C}$................. by rectangular components method.

Ans: To determine the resultant, we have to find its magnitude and direction so

$$R = \sqrt{R_x^2 + R_y^2}$$

$$R = \sqrt{(A_x + B_x + C_x + ...)^2 + (A_y + B_y + C_y + ...)^2}$$

Direction

$$\theta = \tan^{-1}\left(\frac{R_y}{R_x}\right)$$

$$\theta = \tan^{-1}\left(\frac{A_y + B_y + C_y + ...}{A_x + B_x + C_x + ...}\right)$$

(25) Mention various steps for vector addition by rectangular components.

Ans: The vector addition by rectangular components consists of the following steps.

(i) Find x and y components of all given vectors.

(ii) Find x – component R_x of the resultant vector by adding the x – components of all the given vectors.

(iii) Find y-component R_y of the resultant vector by adding y – components of all the given vectors.

(iv) Find the magnitude of the resultant vector $\vec{R}$ using

$$R = \sqrt{R_x^2 + R_y^2}$$

(v) Find the direction of the resultant vector $\vec{R}$ by using equation.

$$\theta = tan^{-1}\left(\frac{R_y}{R_x}\right)$$

(26) If $\vec{A} = 4\hat{i} - 4\hat{j}$, What is the orientation of $\vec{A}$? **LHR-2019 (G-I)**

Ans: As x-component of given vector A is positive and y-component is negative therefore, this vector will lie in 4th quadrant.

As we know that $\theta = 360^o - \phi$

$$\phi = \tan^{-1}\left(\frac{A_y}{A_x}\right)$$

$$\phi = \tan^{-1}\left(\frac{4}{4}\right) = \tan^{-1}(1) = 45^0$$

$$\theta = 360^0 - \phi$$

$$\theta = 360^0 - 45^0 = 315^0$$

2.3 PRODUCT OF TWO VECTORS

(27) Prove that $\vec{A} = 2\hat{i} - 3j + k$ and $\vec{B} = 4\hat{i} + j - 5k$ are mutually perpendicular.

Ans: $\vec{A} = 2\hat{i} - 3j + k$

$\vec{B} = 4\hat{i} + j - 5k$

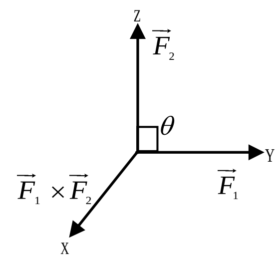
$\vec{A}.\vec{B} = (2\hat{i} - 3j + k).(4\hat{i} + j - 5k)$

$\vec{A}.\vec{B} = (2)(4) + (-3)(1) + (1)(-5)$

$= 8 - 3 - 5 = 0$

Since dot product of two vectors $\vec{A}$ & $\vec{B}$ is equal to zero. So they are perpendicular to each other.

(28) If two vectors $\vec{F_1}$ and $\vec{F_2}$ lie in yz – plane. Then what will be the orientation of $\vec{F_1} \times \vec{F_2}$?



Ans: The cross product of two vectors $\vec{F_1}$ and $\vec{F_2}$ is given by

$\vec{F_1} \times \vec{F_2} = F_1 F_2 \sin\theta n$

By using right hand rule the direction of $\vec{F_1} \times \vec{F_2}$ is perpendicular to yz -plane i.e along x – axis.

(29) Show that the self dot product of vector $\vec{A}$ is equal to the square of its magnitude.

Ans: The dot product of a vector with itself is called self dot product.

Let $\vec{A}$ be given vector then.

$\vec{A}.\vec{A} = AA\cos\theta \qquad \theta = 0^o$

$= AA \cos 0^o$

$= A^2 (1) = A^2$

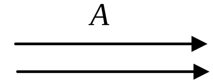
(30) If we have two non-zero vectors $\vec{A}$ and $\vec{B}$ then under what condition the dot product of two vectors will be maximum.

Ans: The dot product of two vectors will be maximum when the angle between them is zero.

$\vec{A}.\vec{B} = AB\cos\theta$

$\vec{A}.\vec{B} = AB\cos(0)$

$\vec{A}.\vec{B} = AB(\text{maximum value})$



(31) What is dot product? Write the formula of K.E in terms of self dot product of velocity vector.

Ans: The scalar product of two vectors $\vec{A}$ and $\vec{B}$ is a scalar quantity, defined as $\vec{A}.\vec{B} = AB\cos\theta$

As kinetic energy of object of mass m and speed v is given by the relation

$K.E = \frac{1}{2} mv^2$

As we know square of magnitude of vector is equal to its self dot product. So

$v^2 = \vec{v}.\vec{v}$

$K.E = \frac{1}{2} m(\vec{v}.\vec{v})$

(32) What does $\dfrac{\vec{A}\times\vec{B}}{AB\sin\theta}$ represent?

Ans: $\dfrac{\vec{A}\times\vec{B}}{AB\sin\theta}$ represent the unit vector. Which shows the direction of $\vec{A}\times\vec{B}$.

By definition

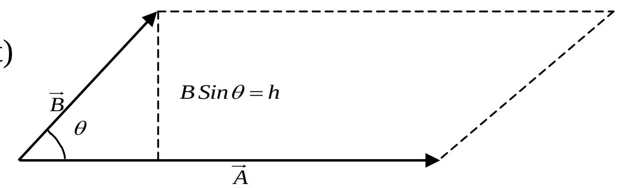
$\vec{A}\times\vec{B} = AB\sin\theta\, n$

$n = \dfrac{\vec{A}\times\vec{B}}{AB\sin\theta}$

It is unit vector perpendicular to plane containing $\vec{A}\, and\, \vec{B}$.

(33) What is the physical significance of cross product of two vectors?

Ans: Magnitude of $\vec{A}\times\vec{B}$ is equal to the area of the parallelogram formed with $\vec{A}\, and\, \vec{B}$ as two adjacent sides.



Area of parallelogram = (length) (height)

$=(A)(B\sin\theta)$

$= AB\sin\theta$

$=\left|\vec{A}\times\vec{B}\right|$

(34) Show that square of a vector is a scalar quantity.

Ans: The scalar product of similar vectors *i.e* $(\vec{A}.\vec{A})$ is called the square of vectors.

$\vec{A}.\vec{A}$ = AA Cos θ = 0^0

$\vec{A}.\vec{A}$ = AA Cos (0)

$\vec{A}.\vec{A} = A^2$

$A^2 = \vec{A}.\vec{A}$

This relation shows that square of a vector is a scalar quantity.

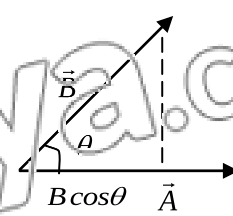
(35) Show that the scalar product of two vectors is commutative.

Ans: The dot product of two vectors $\vec{A}$ and $\vec{B}$ making an angle θ with each other is defined as

$\vec{A}\ .\ \vec{B}$ = (A) (Projection of $\vec{B}$ on $\vec{A}$)

= A (B cosθ)

= AB cosθ … (i)



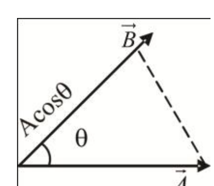
(i)

Similarly,

$\vec{B}\,.\,\vec{A}$ = B (projection of $\vec{A}$ on $\vec{B}$)

$\vec{B}\,.\,\vec{A}$ = B (A cosθ) = BA cosθ

$\vec{B}\,.\,\vec{A}$ = AB cosθ … (ii)



(ii)

From equation (i) & (ii)

$\vec{A}\ .\ \vec{B} = \vec{B}\ .\ \vec{A}$

This shows that scalar product is commutative.

(36) With the help of diagram, show that $\vec{A}\times\vec{B}=-\vec{B}\times\vec{A}$.

Ans: Consider two vectors $\vec{A}$ & $\vec{B}$ making an angle θ with each other. Direction of product vector is obtained by right hand rule.

Rotate the first vector $\vec{A}$ into $\vec{B}$ through the smaller of two possible angles. This rotation is represented by curling the fingers of stretched right hand placed on the first vector $\vec{A}$, then thumb represents the direction of vector product. The direction of $\vec{A}$ x $\vec{B}$ will be vertically upward as shown in the fig **(a)**.

According to this direction rule, $\vec{B}$ x $\vec{A}$ is a vector opposite to the direction of $\vec{A}\times\vec{B}$ as shown in fig **(b)**

Hence $\vec{A}$ x $\vec{B}$ = - $\vec{B}$ x $\vec{A}$

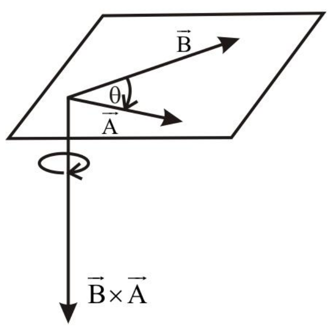


Fig. (b)

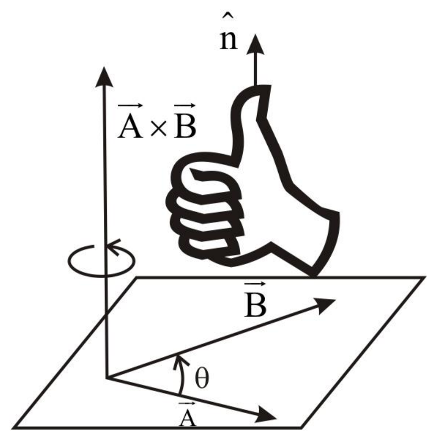


Fig. (a)

(37) Prove that $\vec{A}.\vec{B}$ = $A_xB_x + A_yB_y + A_zB_z$ **DGK-2012**

Ans: Scalar product of two vectors $\vec{A}$ & $\vec{B}$ in terms of their rectangular components.

Let us consider two vectors $\vec{A}$ and $\vec{B}$ in terms of their rectangular components

$\vec{A} = A_x\hat{i} + A_y\hat{j} + A_z k$ $\qquad$ $\vec{B} = B_x\hat{i} + B_y\hat{j} + B_z k$

$\vec{A}.\vec{B} = (A_x\hat{i} + A_y\hat{j} + A_z k).(B_x\hat{i} + B_y\hat{j} + B_z k)$

$\hat{i}.\hat{i} = j.j = k.k = 1$, $\hat{i}.j = j.k = k.i = 0$

$\vec{A}.\vec{B} = A_xB_x + A_yB_y + A_zB_z$

(38) Write any two characteristics of scalar product. **MTN-2012**

Ans: **(i)** If two vectors are parallel then dot product is equal to the product of their magnitudes. i.e. if $\theta = 0^o$

$$\vec{A}.\vec{B} = AB\cos 0^o = AB(1) = AB$$

In case of unit vectors $\hat{i}.\hat{i} = \hat{j}.\hat{j} = \hat{k}.\hat{k} = 1$

And for antiparallel vectors ($\theta = 180^o$)

$$\vec{A}.\vec{B} = AB\ \cos 180^o = AB(-1) = -AB$$

(ii) The self dot product of a vector $\vec{A}$ is equal to square of its magnitude.

$$\vec{A}.\vec{A} = AA\ \cos 0^o = A^2$$

(39) Write any two examples of cross product. **MTN-2012**

Ans: **(i)** Torque about a point is defined as the cross product of position vector $\vec{r}$ and force $\vec{F}$.

$$\vec{\tau} = \vec{r} \times \vec{F}$$

(ii) Angular momentum is defined as the cross product of position vector $\vec{r}$ and linear momentum $\vec{p}$.

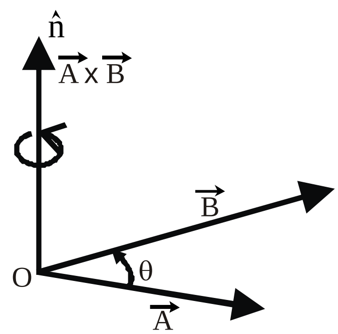
$$\vec{L} = \vec{r} \times \vec{p}$$

(iii) The force $\vec{F}$ experienced by charge particle of charge q moving with velocity $\vec{v}$ in a uniform magnetic field $\vec{B}$ is

$$\vec{F} = q(\vec{v} \times \vec{B})$$

(40) State right hand rule for cross product of two vectors. **GRW-2019 (G-I)**

Ans: First join the tails of two vectors, then rotate the vector $\vec{A}$ which appears first in the product towards the second vector $\vec{B}$ through the smaller angle. The curl fingers of right hand show the direction of rotation, then erect thumb of right hand gives direction of $\vec{A} \times \vec{B}$.



(41) If $\vec{A} = \hat{i} - 2\hat{j} + 3\hat{k}$ and $\vec{B} = 2\hat{i} - \hat{j} + \hat{k}$ then find $\vec{A}.\vec{B}$. **GRW-2019 (G-I)**

Ans: $\vec{A}.\vec{B} = (\hat{i} - 2\hat{j} + 3\hat{k}).(2\hat{i} - \hat{j} + \hat{k})$

$\vec{A}.\vec{B} = (1)(2) + (-2)(-1) + (3)(1)$

$\vec{A}.\vec{B} = 2 + 2 + 3 = 7$

(42) Name two conditions that would makes $\vec{A}_1.\vec{A}_2 = 0$ **DGK-2018 (G-I)**

Ans: Following are the conditions that would make $\vec{A}_1.\vec{A}_2 = 0$

(i) If $\vec{A}_1$ and $\vec{A}_2$ are perpendicular to each other then

$$\vec{A}_1.\vec{A}_2 = A_1A_2\left(\cos 90^0\right) \qquad \because \cos 90^0 = 0$$
$$= 0$$

(ii) Either of vectors $\vec{A}_1$ or $\vec{A}_2$ is a null vector.

$$\vec{A}_1.\vec{A}_2 = (0)A_2\cos\theta = 0$$

or

$$\vec{A}_1.\vec{A}_2 = A_1(0)\cos\theta = 0$$

(43) Show that $\hat{i}.\hat{j} = \hat{j}.\hat{k} = \hat{k}.\hat{i} = 0$. **MTN-2019 (G-II)**

Ans: The scalar product of two mutually perpendicular vectors is zero i.e if $\theta = 90^o$ then

$$\vec{A}.\vec{B} = AB\cos 90^o = 0$$

So, $$\hat{i}.j = |\hat{i}||j|\cos 90^0 = 0$$

$$j.k = |j||k|\cos 90^0 = 0$$

$$k.\hat{i} = |k||\hat{i}|\cos 90^0 = 0$$

Therefore, $\hat{i}.\hat{j} = \hat{j}.k = k.\hat{i} = 0$

2.4 TORQUE

(44) Give two factors on which turning effect depends. **FSD-2019 (G-I)**

Ans: Torque depends upon following factors by formula:

$$\vec{\tau} = \vec{r} \times \vec{F} = rF\sin\theta\hat{n}$$

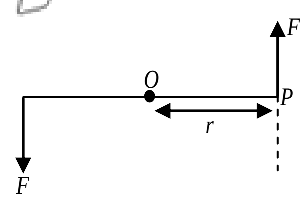
(i) Force (If force is greater in magnitude more will be the torque and vice versa)

(ii) Moment arm (if moment arm is greater more will be the turning effect and vice versa)

(iii) Torque also depends upon the sine of angle between force and position vector.

(45) Define the moment arm

Ans: The perpendicular distance between the line of action of force and axis of rotation is called moment arm. In the given figure moment arm = OP = r



(46) What is the rotational analogous of force?

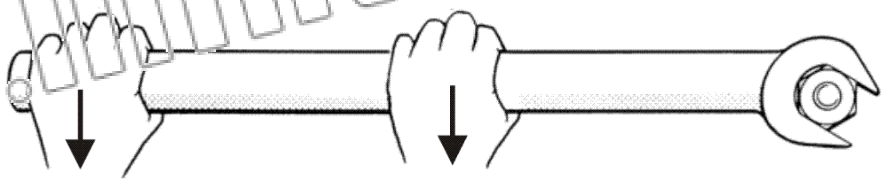
Ans: Torque is rotational analogous of force which produces the linear acceleration in a body. The torque acting on a body produces angular acceleration.

(47) What is the moment of a force about the point lying on the axis of rotation?

LHR-2017(G-I)

Ans: It is turning effect of a force produced in a body about an axis. It is measured by the product of force and moment arm and is denoted by $\vec{\tau}$.

Let $\vec{F}$ be the force and $\vec{r}$ be the position vector of the point w.r.t. pivot point, then toque is $\vec{\tau} = \vec{r} \times \vec{F}$. It is vector quantity has direction along the normal to plane containing $\vec{r}$ and $\vec{F}$.



This means torque τ is equal to the product of force F and moment arm ℓ.

$$\tau = \ell F$$

(48) What is difference between moment arm and moment of force? FSD-2017

Ans: **Torque:** It is turning effect of a force produced in a body about an axis. It is measured by the product of force and moment arm and is denoted by $\vec{\tau}$.

Moment Arm: It is the perpendicular distance between line of action of force and pivot point. Usually it is denoted by "ℓ"