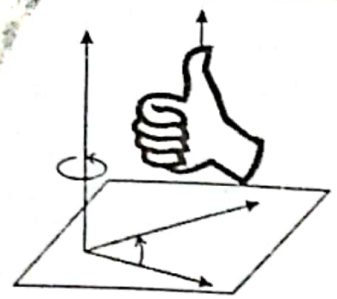


Chapter 2

VECTORS AND EQUILIBRIUM

KEY POINTS

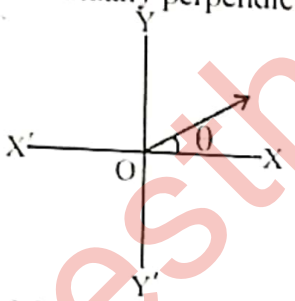
Vectors:

Physical quantities that have both magnitude and directional properties are called vectors. A vector denoted by bold face characters such as **A, d, r** and **v** while in handwriting, we put an arrowhead over the letter e.g. $\vec{A}$.

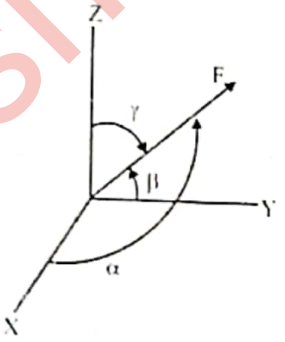
Rectangular coordinate system:

The arrangement of mutually perpendicular axes is called rectangular or Cartesian coordinate system.

- **Two dimensional:** It consists of two mutually perpendicular lines, called x-axis and y–axis.



- **Three dimensional:** It consists of three mutually perpendicular lines called x-axis, y-axis and z-axis.



Addition or Subtraction of Vectors:

Vectors are added or subtracted by using head to tail rule.

- **Head to tail rule:** "If vectors are arranged in such a way that tail of each next vector join with the head of its preceding vector, then the resultant is obtained by joining tail of first vector with the head of last one."

Types of Vector:

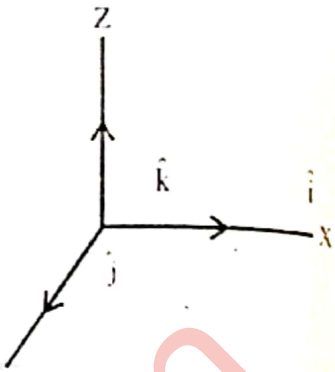
- **Null vector:** The vector having the zero magnitude and arbitrary direction. And is denoted by $\vec{O}$ for example the sum of a vector and its negative vector is a null vector.

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

- **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. It is given by

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

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

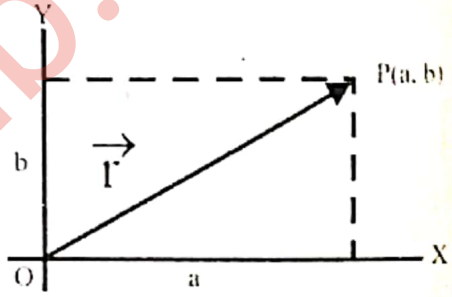


$\hat{i}$ shows unit vector along x-axis

$\hat{j}$ shows unit vector along y-axis

$\hat{k}$ shows unit vector along z-axis

- **Equal vectors:** Vectors having same magnitude and same direction are said to be equal vectors
- **Parallel Vectors**
  The vectors that have only same direction are called parallel vectors
- **Anti parallel Vectors**
  The vectors that have opposite direction are called anti parallel vectors.
- **Position Vector**
  It represents the position of a point with respect to origin in a coordinate system. Its symbol is **r**. In two dimensions.

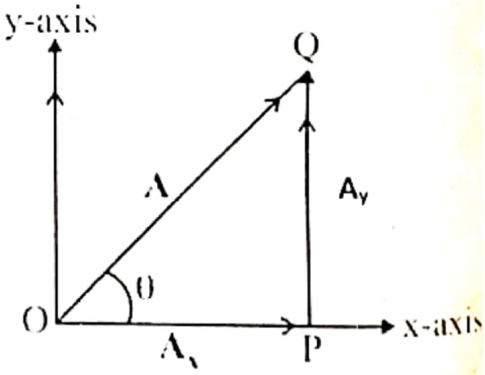


$$\vec{r} = a\hat{i} + b\hat{j}$$

In three dimensions, $\vec{r} = a\hat{i} + b\hat{j} + c\hat{k}$

Rectangular Components of a Vector:

- Components of vector which are mutually perpendicular to each other are called rectangular components.



- **x-component of vector:**
  $A_x = A\cos\theta$ ---------- (i)
- **Y-component of vector:**
  $A_y = A\sin\theta$ ----------(ii)
- **Magnitude of vector:**
  $|A| = \sqrt{Ax^2 + Ay^2}$
- **Direction of resultant vector:**

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

Addition of Vectors By Rectangular Components:

- Suppose the resultant of two vectors **A** and **B** be **R**. Its magnitude is given as

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

Where

$$R_x = A_x + B_x$$
$$R_y = A_y + B_y$$

- **Direction of the resultant vector is given by**

$$\theta = \tan^{-1}(R_y/R_x)$$

- **For any number of vectors the magnitude of the resultant**

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

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

- **conventions for measuring angle of resultant vector,**

Condition	Quadrant	Angle made by resultant	Calculated angle according to conventions.
$R_x \rightarrow$ +ve $R_y \rightarrow$ +ve	1st	φ	$\theta = \varphi$
$R_x \rightarrow$ -ve $R_y \rightarrow$ +ve	2nd	φ	$\theta = 180- \varphi$
$R_x \rightarrow$ -ve $R_y \rightarrow$ -ve	3rd	φ	$\theta = 180+ \varphi$
$R_x \rightarrow$ +ve $R_y \rightarrow$ -ve	4th	φ	$\theta = 360- \varphi$

Scalar or Dot Products:

If the product of two vectors is a scalar, then the product is called scalar product or dot product.

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

e.g: Energy, work, power etc.

Characteristics of scalar product

Let us consider two vector $\vec{A}$ and $\vec{B}$ to elaborate characteristics.

- Scalar product holds commutative law i.e.

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

- If $\theta=90^\circ$, $\vec{A}.\vec{B}=0$
- $\hat{i}.\hat{j}=\hat{j}.\hat{k}=\hat{k}.\hat{i}=0$
- To find angle between two vector to be multiplied.

$$\theta = Cos^{-1}\left(\frac{A_xB_x + A_yB_y + A_zB_z}{AB}\right)$$

- Self scalar product is given by.

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

- If $\vec{A}$ is anti parallel to $\vec{B}$ $(\theta=180^0)$

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

Vector Or Cross Product:

If product of two vectors is a vector, then it is called vector product

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

where $\hat{n}$ is normal to the plane containing vectors **A** and **B.**

Characteristics of vector product

- Cross product does not obeys commutative law
- $\vec{A} \times \vec{B} \neq \vec{B} \times \vec{A}$
- $\vec{A} \times \vec{A} = 0$, therefore, $\hat{i} \times \hat{i} = \hat{j} \times \hat{j} = \hat{k} \times \hat{k} = \vec{0}$

- $\vec{A} \times \vec{B} = AB\hat{n}$ if $\theta = 90°$,
- Therefore, $\hat{i} \times \hat{j} = \hat{k}$, $\hat{j} \times \hat{k} = \hat{i}$, $\hat{k} \times \hat{i} = \hat{j}$
- $\hat{i} \times \hat{k} = -\hat{j}$ $\hat{k} \times \hat{j} = -\hat{i}$, $\hat{j} \times \hat{i} = -\hat{k}$
- if $\theta = 270°$ then $|\vec{A} \times \vec{B}| = ABSin270° = -AB$
- if $\vec{A} \| \vec{B}$ then $\vec{A} \times \vec{B} = \vec{O}$
- $\vec{A} \times \vec{B} = (A_yB_z - B_yA_z)\hat{i} + (A_zB_x - B_zA_x)\hat{j} + (A_xB_y - B_xA_y)\hat{k}$
- $\vec{A} \times \vec{B} = \begin{vmatrix} \hat{i} & j & \hat{k} \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix}$
- The magnitude of $\vec{A} \times \vec{B}$ gives area of parallelogram

Torque:

The product of force and the moment arm is called Torque.

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

Moment arm:

The perpendicular distance from the axis of rotation to the direction of line of action o the force is called moment arm.

Equilibrium:

If a body keeps its state of rest or uniform motion invariant under many forces, it is sai to be in perfect equilibrium.

Conditions of Equilibrium:

The conditions of equilibrium can be stated in terms of coplanar forces as follow:-

1st Condition of Equilibrium

The sum of forces acting on a body is equal to zero.

i.e. $\sum \vec{F} = 0$

For coplanar forces

$\Sigma \vec{F_x} = 0$ *and* $\Sigma \vec{F_y} = 0$

2nd Condition of Equilibrium

The sum of torques acting on a body should be equal to zero. Mathematically

$\Sigma \vec{\tau} = 0$

Anticlockwise torque = clockwise torque

TOPICAL MULTIPLE CHOICE QUESTIONS

Topic 2.1:

Basic Concept of Vectors

1) **A vector is a physical quantity which**
(a) has magnitude and obeys commutative law of addition
(b) has magnitude as well as direction
(c) has magnitude direction and obeys commutative law of addition
(d) none of these

2) **_____makes a difference between scalar and vector.**
(a) magnitude (b) direction
(c) representation (d) dimension

3) **Which of the following vectors is a unit vector?**
(a) $\cos\theta\hat{i}+\sin\theta\hat{j}$ (b) $\frac{1}{\sqrt{2}}\hat{i}+\frac{1}{\sqrt{2}}\hat{j}$
(c) $\frac{1}{\sqrt{3}}\hat{i}+\frac{1}{\sqrt{3}}\hat{j}+\frac{1}{\sqrt{3}}\hat{k}$ (d) all of these

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

5) **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

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

7) **Which of the following is not a null vector?**
(a) $\vec{A}+\vec{B}=\vec{C}$ where $\vec{B}$ is negative vector of $\vec{A}$
(b) $\vec{A}\times\vec{B}=\vec{C}$ where $\vec{A}$ and $\vec{B}$ are equal vectors
(c) position vector of origin
(d) none of these

8) **If we resolve a vector into components along mutually perpendicular directions then such components are called**
(a) rectangular components (b) components of a vector
(c) scalar components (d) all of these

9) **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°

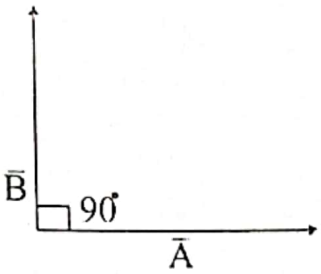
10) **The direction of a vector in plane is described by an angle which the vector makes with _____ and is in_____**
(a) +ve x-axis, anticlockwise (b) -ve x-axis, anticlockwise
(c) +ve y-axis, clockwise (d) -ve y-axis, anticlockwise

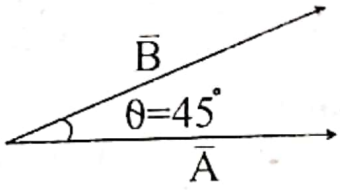
11) **The unit vector of $\vec{A}=\hat{i}+\hat{j}+\hat{k}$ is**
(a) $\vec{A}$ (b) $\frac{1}{\sqrt{3}}$
(c) $\frac{(\hat{i}+\hat{j}+\hat{k})}{\sqrt{3}}$ (d) zero

(12) If $|\vec{A}+\vec{B}| = |\vec{A}-\vec{B}|$ then angle between vectors $\vec{A}$ and $\vec{B}$ is

(a) 45°
(b) 90°
(c) 120°
(d) 180°

(13) For which of the following orientations resultant of two vectors $\vec{A}+\vec{B}$ gives us a maximum?

(a)


(b)


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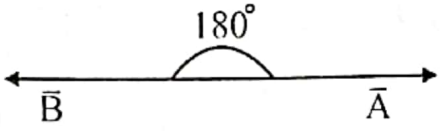

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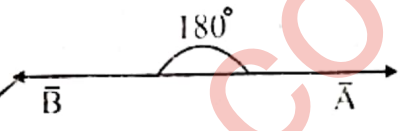
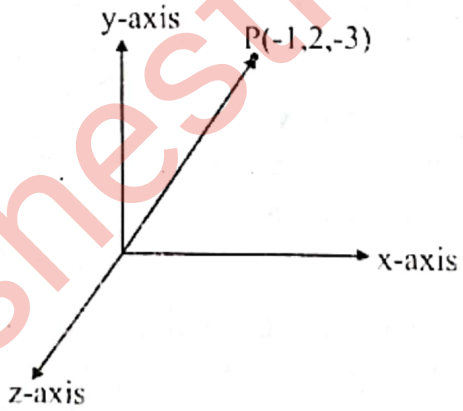


(14) If a vector $\vec{A}$ makes an angle of 45° with x-axis, then:

(a) $\vec{A}_x = \vec{A}_y$
(b) $\vec{A}_x > \vec{A}_y$
(c) $\vec{A}_x < \vec{A}_y$
(d) not possible

(15) The position vector $\vec{r}$ of a point p (-1, 2, -3) is given by the diagram. The length of its component along "X" and "Z" axis is



(a) (-1,-3)
(b) (-1,+3)
(c) (+1,-3)
(d) (+1,+3)

(16) 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

(17) Which of the given can not be represented on graph

(a) unit vector
(b) null vector
(c) position vector
(d) equal vectors

18) A vector has same magnitude but opposite direction to that of given vector is called

(a) equal vectors
(b) unequal vector
(c) antiparallel vector
(d) negative of given vector

9) If α, β, γ are each 90° then length of the vector $\vec{R} = \hat{i}\cos\alpha + \hat{j}\cos\beta + \hat{k}\cos\gamma$ is

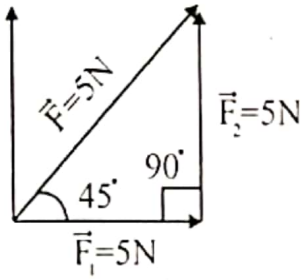
(a) 0
(b) 90
(c) 1
(d) 270

(20) **Parallel vectors must have same**
(a) magnitude
(b) direction
(c) both magnitude and direction
(d) same magnitude but opposite direction

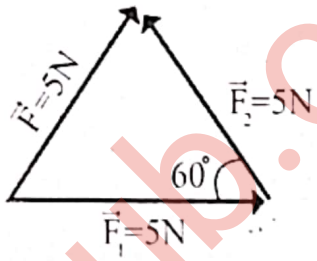
(21) **Which process is not possible for two vectors**
(a) addition
(b) subtraction
(c) division
(d) multiplication

(22) **When a vector is multiplied with a scalar then the possibilities are**
(a) its magnitude may or may not change
(b) its direction may or may not change
(c) its dimensions may or may not change
(d) all of these

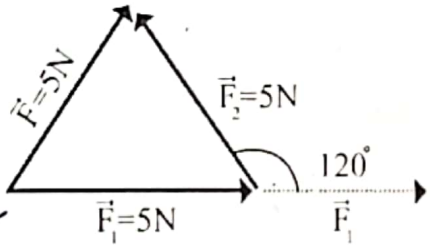
(23) **The resultant of two forces of magnitude 5N each, has also magnitude of 5N, which of the following diagrams best represent the angle between two forces?**



(a)



(b)



(c)

(d) both B and C

(24) **The process of vector subtraction is similar to the process of**
(a) multiplication of vectors
(b) resolution of vectors
(c) addition of vectors
(d) division of vectors

(25) **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

(26) **The relation $\vec{A}+(-\vec{A})$ results the**
(a) parallel vector
(b) unit vector
(c) null vector
(d) position vector

(27) **Graphically the direction of vector in a plane is denoted by**
(a) point
(b) line
(c) arrow head
(d) an angle

(28) **The a_y component of a vector "a" of magnitude 90N making an angle of 30^0 with x-axis is**
(a) 45N
(b) 1N
(c) 5N
(d) 10N

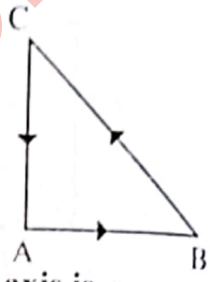
(29) **A vector which has the same affect as all the original vectors taken together is called:**
(a) position vector
(b) null vector
(c) equal vector
(d) resultant vector

(30) 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

(31) A vector has x-component 8 N and y-component 6N. The magnitude of the vector is
(a) 10N (b) 14N
(c) 2N (d) 5N

(32) Two anti-parallel vectors will have the unit vectors which are
(a) equal (b) negative of each other
(c) null vectors (d) none of these

(33) Three forces start acting simultaneously on a particle moving with velocity, $\vec{v}$. These forces are represented in magnitude and direction by the three sides of a triangle ABC (as shown). The particle will now move with velocity.



(a) $\vec{v}$, remaining unchanged
(b) less then $\vec{v}$
(c) greater than $\vec{v}$
(d) $|\vec{v}|$ in the direction of the largest force BC.

(34) If rectangular components of a vector are equal, then its angle with y-axis is
(a) 30^0 (b) 45^0
(c) 60^0 (d) 90^0

(35) Which of the following property is valid for vector addition
(a) associative (b) commutative
(c) distributive (d) all of these

(36) Which of the following is not a vector quantity
(a) velocity (b) speed
(c) momentum (d) acceleration

(37) The minimum number of coplanar forces of equal magnitude whose vector sum can be zero, is
(a) 3 (b) 2
(c) 1 (d) 4

(38) The $\vec{r} = a\hat{i} + b\hat{j} + c\hat{k}$ for the P (a, b, c) is
(a) equal vector (b) position vector
(c) Unit vector (d) negative vector

(39) The minimum number of vectors of unequal magnitude whose vectorial sum is a null vector are
(a) 2 (b) 3
(c) 4 (d) 5

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

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

Topic 2.2:

Vector Addition by Rectangular Components

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

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

(44) **Vector $\overline{A}$ is along y-axis. Its x-component will be**
(a) A cos0
(b) 0
(c) A
(d) A sin0

(45) **The direction of vector $\overline{R}$ is given by**
(a) $\theta = \tan^{-1}(\frac{R_y}{R_x})$
(b) $\theta = \tan^{-1}(\frac{R_x}{R_y})$
(c) $\theta = \sin^{-1}(\frac{R_x}{R_y})$
(d) $\theta = \tan^{-1}(\frac{R_y}{R_x})$

(46) **If R_x is positive and R_y is negative then the resultant lies in**
(a) 1st quadrant
(b) third quadrant
(c) fourth quadrant
(d) 2nd quadrant

(47) **When a force of 100 N makes an angle of 60° with y-axis, its y-component is**
(a) 10N
(b) 5N
(c) 50N
(d) 15N

(48) **If a vector $\overline{A}$ lies in 3rd quadrant then its direction is given by 0 =**
(a) Φ
(b) 180°-Φ
(c) 180°+ Φ
(d) 360°-Φ

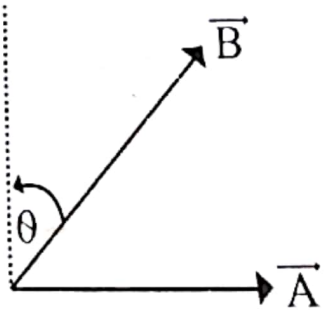
(49) **If a vector $\overline{A}$ lies in 4th quadrant and make angle of 60° with y-axis its direction is given by 0 =**
(a) 30°
(b) 330°
(c) 270 °
(d) none

Topic # 2.3:

Products of Two Vectors (Scalar and Vector products)

(50) $\hat{i}.\hat{i} =$
(a) $\hat{i}$
(b) i^2
(c) 1
(d) 2

(51) **Consider the coplanar vectors. The product $\overline{A} \times \overline{B}$**
(a) $(AB\sin\theta)\hat{n}$
(b) $(AB\cos\theta)$
(c) $(AB\tan\theta)\hat{n}$
(d) $(AB\cos\theta)\hat{n}$



(52) **The vector sum of two forces is perpendicular to their vector differences. In that case, the forces**
(a) are equal to each other
(b) are equal to each other in magnitude
(c) are not equal to each other in magnitude
(d) cannot be predicted.

(53) 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

54) 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

55) Vector product of two vectors A and B is defined as
(a) AB sin 0 (b) AB sin $0\,\hat{n}$
(c) AB cos0 $\hat{n}$ (d) both 'a' and 'b'

56) 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

57) 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

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

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

60) 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

61) If $\vec{A}.\vec{B}=0$, 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

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

63) 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

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

65) Vector A is making angle 0 with y-axis its rectangular components have magnitude
(a) Ax = A Sin0, Ay=A Cos0 (b) Ax = A Cos0, Ay=A Sin0
(c) Ax=A tan0, Ay = A Cot0 (d) Ax= A Cot0, Ay = A tan0

(66) $\hat{j}.\hat{i} =$

(a) 1
(b) zero
(c) $\hat{k}$
(d) $-\hat{k}$

(67) If the dot product is negative, then angle between the vectors is

(a) 0°
(b) 90°
(c) 180°
(d) 270°

(68) 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) $\vec{C}=\vec{A}.\vec{B}\cos 0$
(d) both a and b

(69) What is the angle between $(\vec{A}-\vec{B})$ and $(\vec{A}\times\vec{B})$?

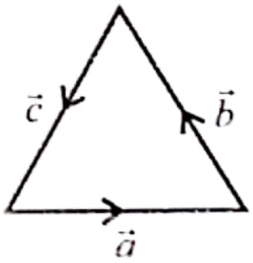
(a) 0°
(b) $\frac{\pi}{2}$ radian
(c) π radian
(d) $\frac{3\pi}{2}$ radian

(70) If $|\vec{A}\times\vec{B}| = |\vec{A}.\vec{B}|$ then angle between the vectors is

(a) 0°
(b) 90°
(c) 180°
(d) 45°

(71) Cross-product of two parallel vectors is:

(a) Maximum
(b) negative
(c) zero
(d) null vector



(72) If is an equilateral triangle then $\vec{a}.\vec{c}$ is

(a) $ac\cos 60°$
(b) $-ac\cos 120°$
(c) $-ac\cos 60°$
(d) All of these

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

(a) 1
(b) zero
(c) A
(d) A Cos0

(74) If $\vec{A} = \vec{B}$ then which equation is not correct

(a) $\hat{A}.\hat{B}=AB$
(b) $\hat{A}=\hat{B}$
(c) A = B
(d) all are correct

(75) Which of the following is a scalar product

(a) torque
(b) work
(c) power
(d) both work and power

(76) Scalar projection of vector $\vec{B}$ on $\vec{A}$ is written as

(a) B Cos0
(b) A Cos0
(c) AB Cos0
(d) A Sin0

(77) $(\hat{i}\times\hat{j})+(\hat{j}\times\hat{k})$ is equal to

(a) 1
(b) null vector
(c) zero
(d) $\hat{i}+\hat{k}$

(78) Self cross product of a vector is equal to

(a) zero
(b) null vector
(c) one
(d) negative

(79) **Which one is correct**

(a) $\vec{A}.\vec{B} = -\vec{A}.\vec{B}$ (b) $\vec{A} \times \vec{B} \neq \vec{B} \times \vec{A}$

(c) $\vec{A} \times \vec{B} = \vec{B} \times \vec{A}$ (d) none of these

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

(a) Zero (b) AB Cos 0

(c) AB Sin 0 (d) AB

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

(a) 1 (b) 0

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

(82) **Which condition could make $\vec{A} \times \vec{B} = \vec{0}$**

(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

(83) **At which angle the scalar product could be negative**

(a) 60^0 (b) 90^0

(c) 180^0 (d) 45^0

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

(a) 0^0 (b) 90^0

(c) 60^0 (d) 45^0

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

(a) zero (b) 1

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

(86) **If the angle between the vectors $\vec{A}$ and $\vec{B}$ is 0. the value of the product $(\vec{B} \times \vec{A}).\vec{A}$ is equal to.**

(a) Zero (b) $BA^2 \sin 0 \cos 0$

(c) $BA^2 \sin 0$ (d) $BA^2 \cos 0$.

(87) **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

(88) **Which property does not hold for vector product**

(a) associative property (b) commutative property

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

(89) **The expression $\frac{A_x B_x + A_y B_y + A_z B_z}{AB}$ is equal to**

(a) Cos0 (b) Sin0

(c) tan0 (d) projection of $\vec{A}$ on $\vec{B}$

(90) **A vector is not changed if**

(a) it is displaced parallel to itself (b) it is rotated through an arbitrary angle.

(c) it is cross-multiplied by a unit vector (d) it is multiplied by an arbitrary scalar.

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

(a) 1

(92) For the two perpendicular vectors, cross product has value
(a) maximum
(b) minimum
(c) zero
(d) none of these

(93) 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

(94) $\vec{A}\times\vec{B}$ 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

(95) 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

(96) 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

(97) 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

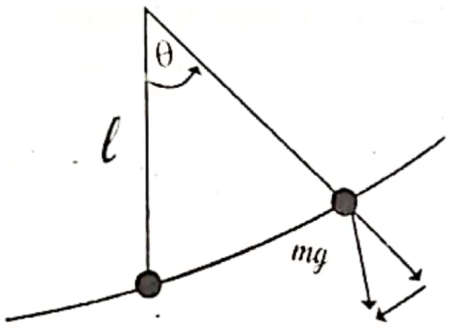
(98) If $\hat{t}$ and $\hat{r}$ are tangential and radial unit vectors then $\hat{r}.\hat{t}$ is
(a) 1
(b) sin0.
(c) 0
(d) cos0.

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

Topic # 2.4:

Torque

(100) Consider the figure showing pendulum. Torque on the pendulum is.



(a) mgl
(b) $mgl\cos\theta$
(c) $mgl\sin\theta$
(d) Zero.

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

(102) Let $\vec{F}$ be the force acting on a particle having position vector $\vec{r}$ and $\vec{\tau}$ be the torque of this force about the origin. Then

(a) $\vec{r}.\vec{\tau}=0$ and $\vec{F}.\vec{\tau}=0$
(b) $\vec{r}.\vec{\tau}=0$ and $\vec{F}.\vec{\tau}\neq 0$
(c) $\vec{r}.\vec{\tau}\neq 0$ and $\vec{F}.\vec{\tau}=0$
(d) $\vec{r}.\vec{\tau}\neq 0$ and $\vec{F}.\vec{\tau}\neq 0$

(103) Conventionally, clockwise torque is taken as

(a) zero
(b) negative
(c) positive
(d) none of these

(104) Torque has maximum value if angle between $\vec{r}$ and $\vec{F}$ is

(a) 30^0
(b) 90^0
(c) 45^0
(d) 60^0

(105) 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

(106) 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

(107) A body is said to be in complete equilibrium if

(a) $\sum \vec{F} = 0$
(b) $\sum \vec{\tau} = 0$
(c) $\sum \vec{F} = 0$ or $\sum \vec{\tau} = 0$
(d) $\sum \vec{F} = 0$ and $\sum \vec{\tau} = 0$

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

(a) position vector w.r.t pivot point
(b) Couple arm
(c) radius vector
(d) momentum arm

(109) A 5N weight is balanced on the top of a vertical wheel of radius 1m. The torque, exerted by the weight, on the axis of rotation of the wheel is

(a) 5 Nm
(b) 6 Nm
(c) 1 Nm
(d) Zero.

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

(a) Maximum
(b) minimum
(c) zero
(d) negative

(111) 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

(112) The torque acting on a body determines its

(a) angular velocity
(b) angular displacement
(c) force
(d) angular acceleration

(113) Torque is analogous of

(a) force for rotational motion
(b) force for linear motion
(c) angular velocity
(d) angular momentum

Topic 2.5:

Equilibrium (1st and 2nd Condition)

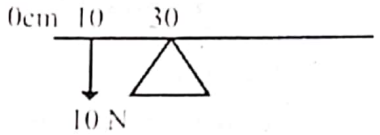
(114) **If a body is at rest or moving with uniform velocity then it is said to be in**
(a) momentum (b) moment arm
(c) torque (d) equilibrium

(115) **If a body is moving with uniform velocity it is said to be in**
(a) static equilibrium (b) dynamic equilibrium
(c) kinematics equilibrium (d) none of these

(116) **For a body to be in complete equilibrium, both linear and angular acceleration should be**
(a) maximum (b) zero
(c) remain same (d) none of these

(117) **1st condition of equilibrium is written as**
(a) $\vec{F} = 0$ (b) $\sum \vec{F} = 0$
(c) $\sum \vec{\tau} = 0$ (d) none

(118) **Consider the balanced meter rod weight of this uniform meter rule is.**



(a) 30 N (b) 10 N
(c) 20 N (d) 15 N

(119) **Coplanar forces are those forces which are**
(a) Right angle to each other (b) Parallel to each other
(c) Anti parallel to each other (d) Acting in common plane

(120) **Second condition of equilibrium controls**
(a) translational equilibrium (b) static equilibrium
(c) rotational equilibrium (d) none

(121) **The least number of unequal forces whose resultant will be zero**
(a) 2 (b) 3
(c) 4 (d) 5

(122) **If 2nd condition of equilibrium is satisfied there is no angular acceleration and the body will be in**
(a) Static equilibrium (b) dynamic equilibrium
(c) Limiting equilibrium (d) none

MULTIPLE CHOICE QUESTIONS

(From Past Papers 2012-2017)

(Federal Board)

(1) What is the angle between the two vectors? $A=5\hat{i}+\hat{j}$ and $B=2\hat{i}+4\hat{j}$? (FDR 2012)

(a) 66° (b) 52°

(c) 25° (d) 180°

(2) The X-component of a force of 10 N acting along horizontal, making angle 60° will be _____. (FDR 2013)

(a) 5 N (b) 10 N

(c) 15 N (d) 20 N

(3) If $\vec{A}=4\hat{i}+3\hat{j}$ then its unit vector will be_____. (FDR 2013)

(a) $\frac{2\hat{i}+3\hat{j}}{6}$ (b) $\frac{6}{2\hat{i}+3\hat{j}}$

(c) $\frac{4\hat{i}+3\hat{j}}{5}$ (d) $\frac{5}{4\hat{i}+3\hat{j}}$

(4) The moment of force is called _____ (FDR 2014)

(a) Torque (b) impulse

(c) Angular momentum (d) force

(5) If 'R_x' is negative and 'R_y' component is positive, the direction of resultant 'R' is _____ (FDR 2014)

(a) $\theta=\phi$ (b) $\theta=180^0-\phi$

(c) $\theta=180^0+\phi$ (d) $360^0-\phi$

(6) Two forces each of magnitude F act perpendicular to each other. Their resultant vector will have magnitude (FDR 2015)

(a) 2F (b) $2F^2$

(c) $\sqrt{2}F$ (d) $\frac{F}{\sqrt{2}}$

(7) $\vec{A}.\hat{j}=$ _____ (FDR 2015)

(a) zero (b) A_x

(c) A_y (d) A_z

(8) Which of the following pair contains one vector and one scalar quantity? (FDR 2016)

(a) Impulse, Energy (b) Torque, Angular momentum

(c) Work, Power (d) Impulse, Torque

(9) Two vectors $\vec{A}$ and $\vec{B}$ are enclosing an angle '0'. For which value of 0, $|\vec{A}\times\vec{B}|=|\vec{A}.\vec{B}|$? (FDR 2016)

(a) 60° (b) 90°

(c) 0° (d) 45°

(10) Two forces are acting together on an object. The magnitude of their resultant is minimum, when the angle between the forces is: (FDR 2017)

(a) 120° (b) 180°

(c) 45° (d) 60°

(11) If the Scalar product of two vectors is $2\sqrt{3}$ and the magnitude of their vector product is 2. The angle between them is: (FDR 2017)

(a) 30° (b) 60°

(c) 180° (d) 120°