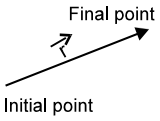
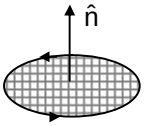
Introduction to vectors

1. **Scalar :** A physical quantity having only magnitude but not associated with any direction is called a scalar.

   eg: time, mass, distance, speed, work, energy, power, pressure, temperature, electric current, gravitational potential, pole strength, magnetic flux, entropy, electric capacity, velocity of light, large angular displacement, electric charge, etc.
2. Scalars are added and subtracted by algebraic method.
3. **Vector :** A physical quantity having magnitude as well as associated direction and which obeys vector laws is called a vector.

   eg: displacement, velocity, acceleration, force, momentum, impulse, moment of force, small angular displacement, angular velocity, angular acceleration, magnetic moment, dipole moment, current density, intensity of electric field or magnetic field, shearing stress, weight, centrifugal force, infinitesimally small area, etc.
4. Vectors are completely described by a number with a unit followed by a statement of direction.
5. Angle can be considered as vector if it is small. Large angles can not be treted as vectors as they do not obey laws of vector addition.
6. Surface area can be treated both as a scalar and a vector. A is magnitude of surface area which is a scalar. This area is enclosed by a closed curve as shown if $\hat{n}$ is a unit vector normal to the surface, we can write $A\hat{n}$ as a vector.

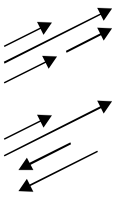
   $\Rightarrow$ Surface area is a vector.

   [If the four fingers of right hand curl along the direction of arrow of enclosing curve, thumb indicates direction of area vector]
7. Tensor is a physical quantity which will have different values along different directions.

   e.g. Moment of inertia, stress.
8. A vector is represented by a directed line segment. The length of the line segment is proportional to the magnitude of the vector.
9. The magnitude or modulus of a vector ($|\vec{r}|$ or r) is a scalar.
10. Electric current, velocity of light has both magnitude and direction but they do not obey the laws of vector addition. Hence they are scalars.
11. **Equal vectors :** Two vectors are said to be equal if they have the same magnitude and direction irrespective of their initial points.
12. **Negative vectors :** $\vec{A}$ and $-\vec{A}$ are vectors having the same magnitude and opposite direction. $-\vec{A}$ is called the negative of $\vec{A}$.
13. **Proper vector :** A vector whose magnitude is not zero is known as proper vector.
14. **Null Vector (Zero Vector):** It is a vector whose magnitude is zero and direction is unspecified.

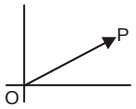
    Examples:

    a) Displacement after one complete revolution.
    b) Velocity of vertically projected body at the highest point
15. **Parallel vectors :** Vectors in the same direction are called parallel vectors.
16. **Antiparallel vectors :** Vectors in opposite direction are called antiparallel vectors.
17. **Like vectors or co-directional vectors :** The vectors directed in the same direction, irrespective of their magnitudes are called co-directional vectors or like vectors.

18. **Collinear vectors :** Two or more vectors parallel or antiparallel to each other are called collinear vectors.
19. **Coplanar vectors :** Vectors lying on the same plane are called coplanar vectors and the plane in which they lie is called the plane of the vectors.
20. **Unit vector :** It is a vector whose magnitude is unity. A unit vector parallel to a given vector.
21. If $\vec{A}$ is a vector, the unit vector in the direction of $\vec{A}$ is written as $\vec{a}$ or $\hat{A} = \frac{\text{vector } \vec{A}}{\text{modulus of } \vec{A}} = \frac{\vec{A}}{|\vec{A}|}$.

    $\hat{i}, \hat{j}$ and $\hat{k}$ are units vectors along x, y and z axis.
22. **Position vector :** The vector which is used to specify the position of a point 'P' with respect to some fixed point 'O' is represented by $\overrightarrow{OP}$ and is known as the position vector of 'P' with respect to 'O'.



23. **Real Vector or Polar Vector:** If the direction of a vector is independent of the coordinate system., then it is called a polar vector. Example: linear velocity, linear momentum, force, etc.,
24. **Pseudo or axial vectors :** Axial vectors or pseudo vectors are those whose direction is fixed by convention and reverses in a mirror reflection. Cross product of two vectors gives an axial vector. eg : Torque, angular velocity, etc.
25. A vector remains unchanged when it is moved parallel to itself.
26. If m is a scalar and $\vec{A}$ a vector, then $m\vec{A}$ is a vector. Its magnitude is m times that of magnitude of $\vec{A}$. Its direction is the same as that of $\vec{A}$, if m is positive and opposite if m is negative,

    $\vec{P} = m\vec{V}$; $\vec{F} = m\vec{a}$;

    $\vec{F} = \vec{E}q$; $\vec{F} = m\vec{B}$. If m is zero, $m\vec{A}$ is a null vector.
27. Vector multiplication obeys commutative law when multiplied by a scalar. $s\vec{A} = \vec{A}s$ where s is scalar.
28. Vector multiplication obeys associative law when multiplier by a scalar i.e. $m(n\vec{A}) = mn\vec{A}$ (m, n are scalars)
29. Vector multiplication obeys distributive law when multiplied by a scalar. $s(\vec{A} + \vec{B}) = s\vec{A} + s\vec{B}$.