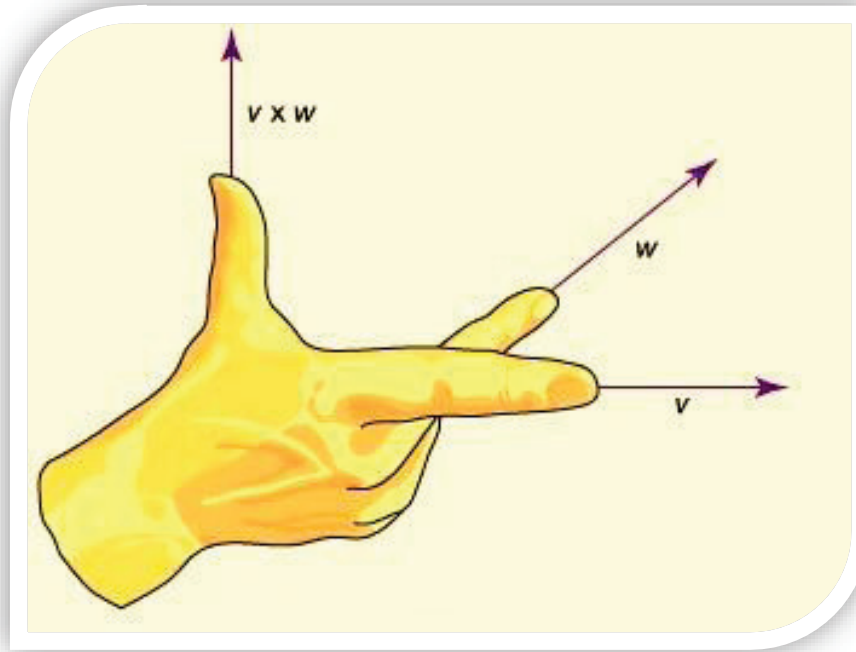


VECTORS



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Vectors

Scalar

A physical quantity which has only magnitude but no direction is called a scalar quality.

E.g: mass, time, volume, distance travelled, speed, etc.

Vector

A physical quantity which has magnitude and direction and which obeys the rules of vector addition is called a vector.

Eg: displacement, velocity, acceleration, force, linear momentum, impulse, etc.

Note: If a physical quantity has magnitude and direction but does not add according to the rules of vector addition it is NOT a vector. E.g: Electric current.

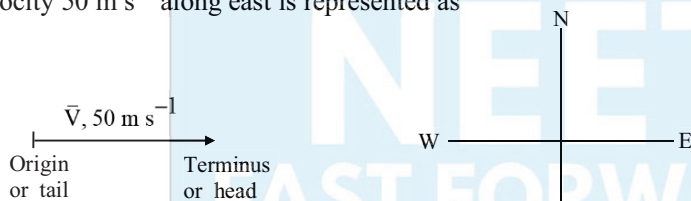
Graphical representation of a vector

A vector is represented by a directed line segment whose orientation gives the direction of vector and whose length is proportional to the magnitude of vector.

The magnitude of a vector is called modulus of the vector. It can never be negative.

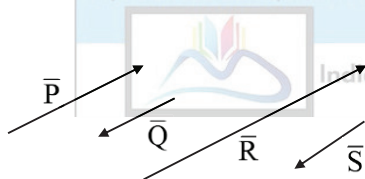
The vectors are denoted as \vec{P} , \vec{Q} , \vec{AB} , \vec{a} , \vec{b} , \vec{ab} , etc.

A velocity 50 m s^{-1} along east is represented as



The length of $\vec{V} \propto$ its magnitude.

Parallel vectors



In the diagram \vec{P} , \vec{Q} , \vec{R} and \vec{S} are called parallel vectors.

Among them:

\vec{P} , \vec{Q} are unlike vectors

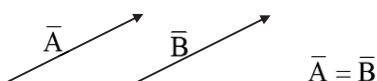
\vec{Q} , \vec{R} are unlike vectors

\vec{P} , \vec{R} are like vectors

\vec{Q} , \vec{S} are like vectors

\vec{R} , \vec{S} are unlike vectors

Equal vectors

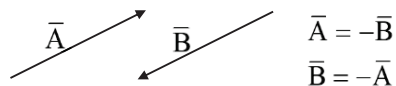


If two vectors belong to the same physical quantity, have same magnitude and direction, they are called **equal vectors**.

Note: If a vector is displaced parallel to itself, it does not change.

Negative of a vector

If two vectors belonging to same physical quantity have same magnitude but are opposite to each other then either of the vectors is called the negative of the other.



Null vector or zero vector ($\vec{0}$)

If the magnitude of a vector is equal to zero, we call it a null vector or a zero vector. The origin and terminus of a zero vector coincide. The direction of a zero vector is indeterminate. It is represented by $\vec{0}$. Ex: The acceleration of a particle in uniform motion is a null vector.

Unit vector

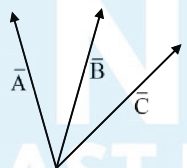
If the magnitude of a vector is equal to one, it is called unit vector. The unit vector along a vector \vec{A} (say) is represented as \hat{A} (which is read as A cap or A hat). Unit vector along \vec{A} is given by

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

where $|\vec{A}|$ (or A) is modulus of vector \vec{A} .

Coinitial vectors or concurrent vectors

If the origins of two or more vectors coincide with one another, then the vectors are called coinital vectors or concurrent vectors.



Coplanar vectors

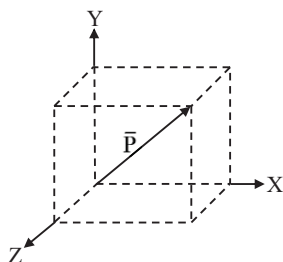
If two or more vectors lie on the same plane, they are called coplanar vectors.



The three vectors \vec{P} , \vec{Q} and \vec{R} shown, are on the plane of the paper and are called coplanar vectors.

Spatial vectors or 3-dimensional vectors

The vectors present in space are called spatial vectors or 3-dimensional vectors.

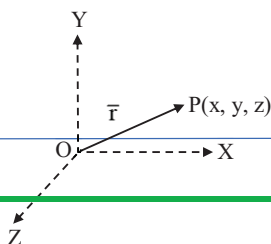


The vector \vec{P} shown in the diagram is an example for a 3-D vector.

Note: Unit vectors along X, Y and Z axes are represented as \hat{i} , \hat{j} and \hat{k} respectively, in the right handed Cartesian co-ordinate system.

Position vector

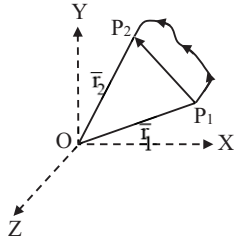
It is used to specify the position of a point with respect to some fixed point which is generally the origin.



In the diagram position vector of a point P is $\overline{OP} = \vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$

Displacement vector

If a particle which is initially at point P₁, move to a point P₂ then the displacement vector is $\overline{P_1P_2}$.

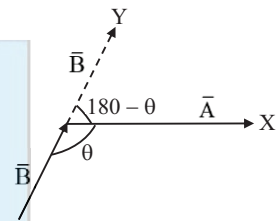


If position vector of initial position P₁ is \vec{r}_1 and position vector of final position P₂ is \vec{r}_2 then displacement vector is $\overline{P_1P_2} = \vec{r}_2 - \vec{r}_1$.

Angle between two vectors

When the tails (or heads) of two vectors coincide, then the smaller angle between the vectors is called angle between the vectors.

In the diagram shown the angle between \vec{A} and \vec{B} is NOT θ . But it is $180 - \theta$.



Addition of two vectors

If 20 kg sugar is added to 10 kg sugar, we get 30 kg sugar. As mass is a scalar, general rules of arithmetic are enough for its addition. But when we add vectors (of same physical quantity) having magnitudes 20 units and 10 units, their sum can have a magnitude (20 - 10) units to (20 + 10) units depending on the angle between two vectors. The sum of vectors is called 'resultant vector'.

Adding two vectors which are in the same direction

\vec{P} 20 units



\vec{Q} 10 units



$\vec{R} = \vec{P} + \vec{Q}$ 30 units



$|\vec{R}| = |\vec{P}| + |\vec{Q}|$ or simply $R = P + Q$ $\therefore R = 20 + 10 = 30$ units

Adding two vectors which are opposite to each other

\vec{P} 20 units



\vec{Q} 10 units



$\vec{R} = \vec{P} + \vec{Q}$

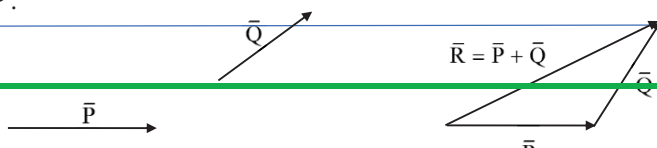


$\vec{R} = \vec{P} + \vec{Q}$; $|\vec{R}| = |\vec{P}| - |\vec{Q}|$ or $R = P - Q = 20 - 10 = 10$ units

Make a note that we are adding \vec{P} and \vec{Q} but not subtracting.

Adding two vectors inclined mutually

Consider \vec{P} and \vec{Q} (shown in figure). Slide \vec{Q} parallel to itself in such a way that the tail of \vec{Q} coincides with the head of \vec{P} .





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