

# GEOMETRIC OBJECTS AND TRANSFORMATIONS – I

## 4.1 Scalars, points and vectors

The basic geometric objects and relationship among them can be described using the three fundamental types called scalars, points and vectors.

### **Geometric Objects.**

- Points:

One of the fundamental geometric objects is a point.

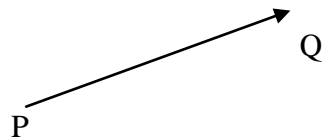
- In 3D geometric system, point is a location in space. Point possesses only the location property, mathematically point neither a size nor a shape.
- Points are useful in specifying objects but not sufficient.

- Scalars:

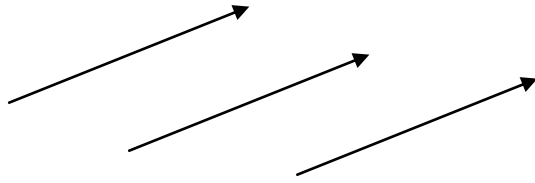
- Scalars are objects that obey a set of rules that are abstraction of the operations of ordinary arithmetic.
- Thus, addition and multiplication are defined and obey the usual rules such as commutativity and associativity and also every scalar has multiplicative and additive inverses.

- Vector:

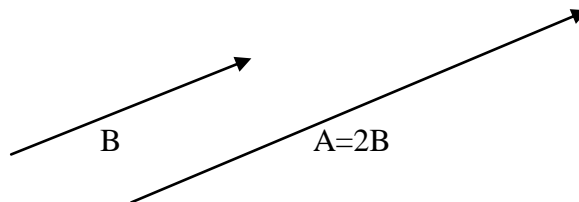
- Another basic object which has both direction and magnitude, however, vector does not have a fixed location in space.
- Directed line segment shown in figure below connects two points has both direction i.e, orientation and magnitude i.e., its length so it is called as a vector



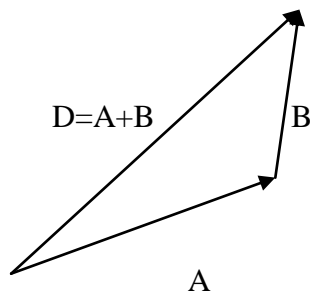
because of vectors does not have fixed position, the directed line segments shown in figure below are identical because they have the same direction and magnitude.



Vector lengths can be altered by the scalar components, so the line segment A shown in figure below is twice the length of line segment B



We can also combine directed line segments as shown in figure below by using the head and tail rule



We obtained new vector D from two vectors A and B by connecting head of A to tail of B. Magnitude and direction of vector D is determined from the tail of A to the head of B, we can call D has sum of A and B, so we can write it as  $D=A+B$ .

Consider the two directed line segments A and E shown in figure below with the same length but opposite direction. We can define the vector E in terms of A as  $E=-A$ , so the vector E is called **inverse vector** of A. The sum of vectors A and E is called **Zero vector**, which is denoted as  $\mathbf{0}$ , that has a zero magnitude and orientation is undefined.

