

## 3.2 POSITION VECTOR

In order to locate the position of a particle, we need to measure the distance of the particle from some reference point and a way to tell the direction from the reference point. A properly marked three-dimensional Cartesian coordinate system with origin at the reference point adequately specifies the location of points in space. Therefore, the values of the three coordinates  $(x, y, z)$  of a point can completely specify the position of a particle as shown in Fig. 3.2.

The vector from the origin of the coordinate system to the location of the particle is called the **position vector**. The position vector is denoted by  $\vec{r}$ . Note that the coordinates  $(x, y, z)$  of  $P$  do not represent any vector, it is the arrow from the origin to the point  $P$  that is the position vector. We say that position of the particle is the space point of coordinates  $(x, y, z)$  and the position vector is the vector  $\vec{r}$  as shown in Fig. 3.2. The position vector can be written using the

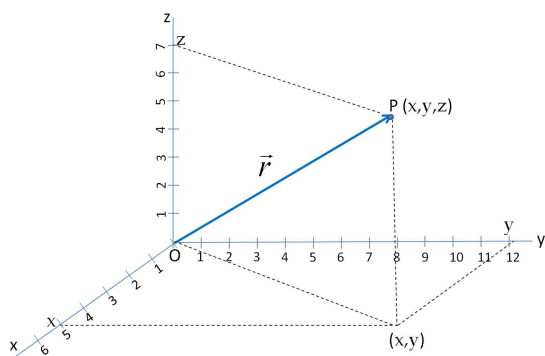


Figure 3.2: Position vector  $\vec{r}$  is pointed from the reference point  $O$  to the location of the point  $P$  in space. Choice of a different origin will change the position vector, which will be from the new origin to the same location  $P$ .

unit base vectors of the Cartesian coordinates, which we have chosen to denote by  $(\hat{u}_x, \hat{u}_y, \hat{u}_z)$ .

$$\vec{r} = x \hat{u}_x + y \hat{u}_y + z \hat{u}_z. \quad (3.1)$$

Since, one end of the position vector is at the arbitrarily chosen reference point, the position vector does depend on the choice of the coordinate system. If the origin of the coordinate system was moved to another place, the position vector from the new origin will be different than the one from the old origin. We will see below that although position vector itself may not be a “true” vector, the change in position, being independent of the choice of a coordinate system, is a true vector.



Figure 3.1: The Hubble telescope took this picture of a stellar group called R136 in the Large Magellanic Cloud. These stars are “young”, only a few million years old. The region is a hotbed for new star births. How would you assign positions to these stars? Photo credits: NASA/ESA.