Applications of the Position Vector

Position vectors are particularly useful when we need to determine the directed distance between two arbitrary points in space.

If the location of point $P_A$ is denoted by position vector $\vec{r}_A$, and the location of point $P_B$ by position vector $\vec{r}_B$, then the directed distance from point $P_A$ to point $P_B$, is:

$$\vec{R}_{AB} = \vec{r}_B - \vec{r}_A$$

We can use this directed distance $\vec{R}_{AB}$ to describe much about the relative locations of point $P_A$ and $P_B$!
For example, the physical **distance** between these two points is simply the magnitude of this directed distance:

\[ d = |\vec{R}_{AB}| = |\vec{r}_B - \vec{r}_A| \]

Likewise, we can specify the **direction** toward point \( P_B \), with respect to point \( P_A \), by find the **unit vector** \( \hat{a}_{AB} \):

\[ \hat{a}_{AB} = \frac{\vec{R}_{AB}}{|\vec{R}_{AB}|} = \frac{\vec{r}_B - \vec{r}_A}{|\vec{r}_B - \vec{r}_A|} \]