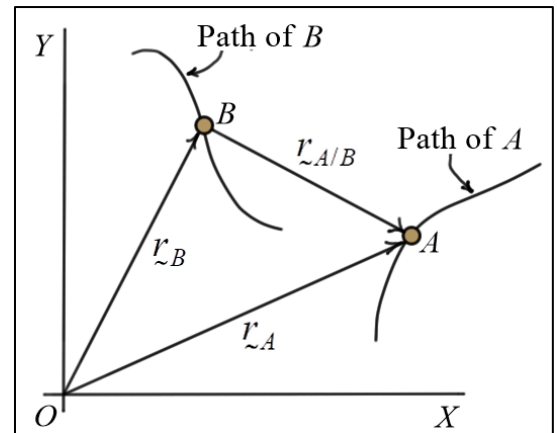


Elementary Dynamics

Relative Motion of Two Particles

The figure shows the paths of motion of two particles A and B . The vectors \underline{r}_A and \underline{r}_B represent the **position vectors** of A and B relative to a fixed point O , and the vector $\underline{r}_{A/B}$ represents the position vector of A **relative to** B (or A with respect to B). Note that $\underline{r}_{A/B}$ starts at B and ends at A .



Sometimes it is convenient to express the motion of a point relative to another moving point. For example, to describe the motion of particle A relative to particle B , first note that

$$\underline{r}_A = \underline{r}_B + \underline{r}_{A/B} \quad \text{or} \quad \boxed{\underline{r}_{A/B} = \underline{r}_A - \underline{r}_B} .$$

Differentiating this expression gives rise to the definitions of the terms “**relative velocity**” and “**relative acceleration.**”

$$\boxed{\underline{v}_{A/B} = \dot{\underline{r}}_{A/B} = \underline{v}_A - \underline{v}_B} \quad \text{“relative velocity – velocity of } A \text{ relative to } B\text{”}$$

$$\boxed{\underline{a}_{A/B} = \ddot{\underline{r}}_{A/B} = \underline{a}_A - \underline{a}_B} \quad \text{“relative acceleration – acceleration of } A \text{ relative to } B\text{”}$$

In words, the motion (velocity or acceleration) of A relative to B represents the **motion** of A as seen by an **observer translating** with B . This concept is used extensively in the analysis of rigid body kinematics.