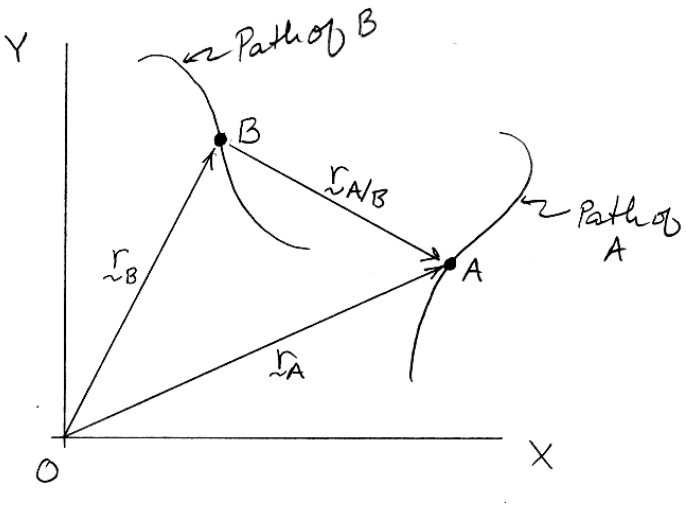
ME 2580 Dynamics
Relative Motion of Two Particles

The figure shows the paths of motion of two particles *A* and *B*. The vectors $\underset{\sim}{r}_A$ and $\underset{\sim}{r}_B$ represent the ***position vectors*** of *A* and *B* relative to a fixed point *O*, and the vector $\underset{\sim}{r}_{A/B}$ represents the position vector of *A* ***relative*** to *B*. (Note that $\underset{\sim}{r}_{A/B}$ 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, we can express the motion of point *A* relative to point *B* as follows: First, note that

$$\underset{\sim}{r}_A = \underset{\sim}{r}_B + \underset{\sim}{r}_{A/B} \qquad \text{or} \qquad \underset{\sim}{r}_{A/B} = \underset{\sim}{r}_A - \underset{\sim}{r}_B .$$

Then, we can ***differentiate*** this expression to define what we mean by the terms "***relative velocity***" and "***relative acceleration***."

$$\underset{\sim}{v}_{A/B} = \dot{\underset{\sim}{r}}_{A/B} = \underset{\sim}{v}_A - \underset{\sim}{v}_B \qquad \text{"relative velocity"}$$

$$\underset{\sim}{a}_{A/B} = \ddot{\underset{\sim}{r}}_{A/B} = \underset{\sim}{a}_A - \underset{\sim}{a}_B \qquad \text{"relative acceleration"}$$

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.