Relative Velocity

1. **Relative velocity:** When the distance between two bodies is altering either in magnitude or direction or both, then each is said to have a relative velocity with respect to the other. Relative velocity is vector difference of velocities.

   a. The relative velocity of body 'A' w.r.t. 'B' is given by $\vec{V}_R = \vec{V}_A - \vec{V}_B$

   b. The relative velocity of body 'B' w.r.t. 'A' is given by $\vec{V}_R = \vec{V}_B - \vec{V}_A$

   c. $\vec{V}_A - \vec{V}_B$ and $\vec{V}_B - \vec{V}_A$ are equal in magnitude but opposite in direction

   d. $\left|\vec{V}_R\right| = \left|\vec{V}_A - \vec{V}_B\right| = \sqrt{V_A^2 + V_B^2 - 2.V_A V_B.\cos\theta}$

   e. For two bodies moving in the same direction, relative velocity is equal to the difference of velocities. ($\theta = 0°.\cos 0 = 1$)

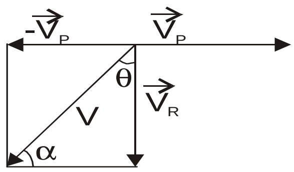
   $\left|\vec{V}_R\right| = V_A - V_B$

   f. For two bodies moving in opposite direction, relative velocity is equal to the sum of their velocities. ($\theta = 180°; \cos 180 = -1$)

   $\therefore \left|\vec{V}_R\right| = V_A + V_B$

   g. If they move at right angle to each other, then the relative velocity $= \sqrt{v_1^2 + v_2^2}$.

2. Rain is falling vertically downwards with a velocity $\vec{V}_R$ and a person is travelling with a velocity $\vec{V}_P$. Then the relative velocity of rain with respect to the person is $\vec{V} = \vec{V}_R - \vec{V}_P$.



Relative velocity $= |\vec{V}| = \sqrt{V_R{}^2 + V_P{}^2}$.

3. The direction of relative velocity (or) the angle with the vertical at which an umbrella is to be held is given by $\tan\theta = \left|\dfrac{\vec{V}_P}{\vec{V}_R}\right|$.