Relative Velocity

Relative Velocity: When one body moves with respect to the other body then the velocity of that body as measured from the other is known as relative velocity.

For example: Two trains are moving and two passengers are boarded on these trains.

Then the velocity of the first with respect to the second train or the velocity of the second train with respect to the observer in the first train is said to be relative velocity between them. Thus relative velocity of the first body with respect to the second body is same as relative velocity of the second body with respect to the first body, only direction is different.

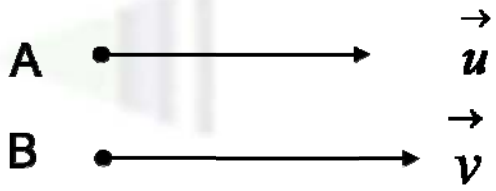
To find the relative velocity between two bodies we proceed as follow:

(1) The body with respect to which the relative velocity is to be found is brought into rest by adding the equal and opposite velocity.

(2) Add the velocity which has been added to first of same magnitude and direction to the second body. Find the resultant of the original velocity and the added velocity.

Case I:

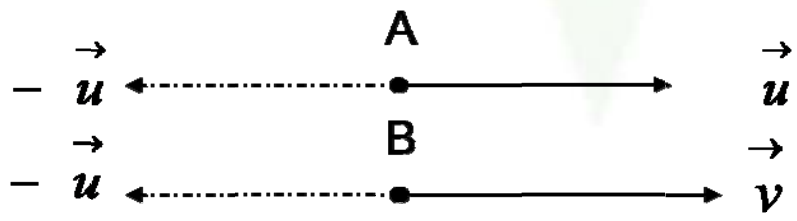
Let both the bodies moves along the same direction. Find the relative velocity of B with respect to A.



(1) Bring A at rest by adding a velocity of magnitude u opposite to the direction of motion i.e. by adding a vector

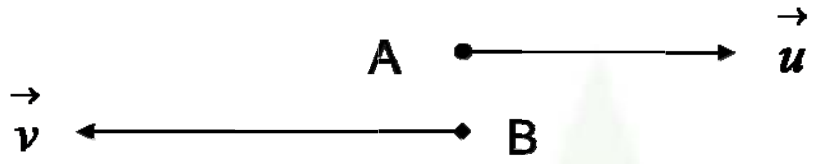
(2) Add the same velocity Vector –u to the body B also.

Resultant of two vectors = $\vec{v} - \vec{u}$



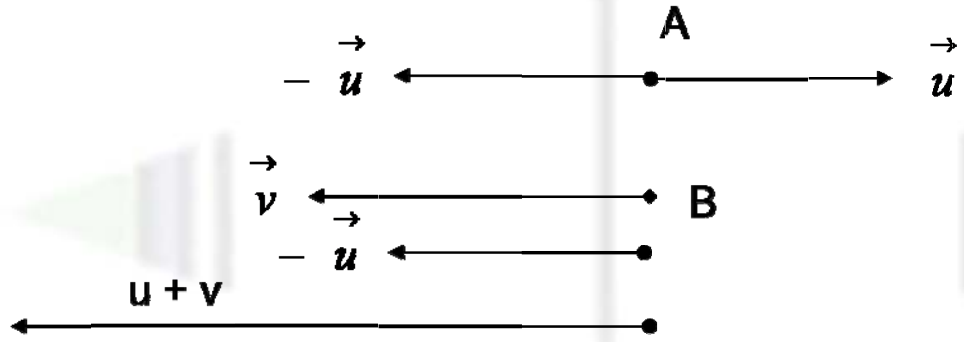
Case II:

The two bodies are moving along opposite direction. Find relative velocity of B with respect to A



(1) Bring A at rest by adding $-\vec{u}$

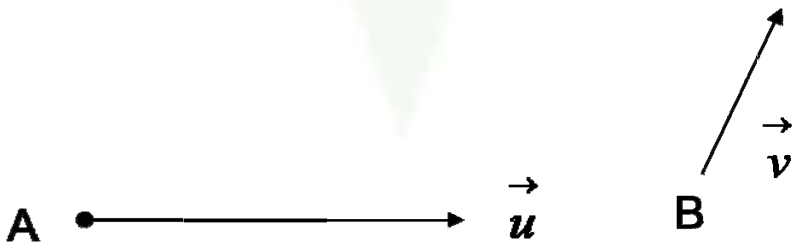
(2) Add the same velocity on body B also



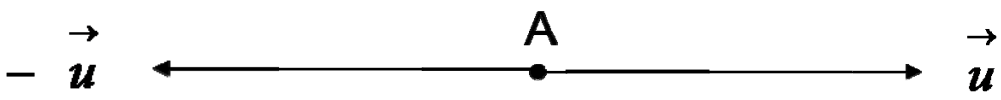
Resultant magnitude of velocity = u + v and direction is along the direction of v

Case III:

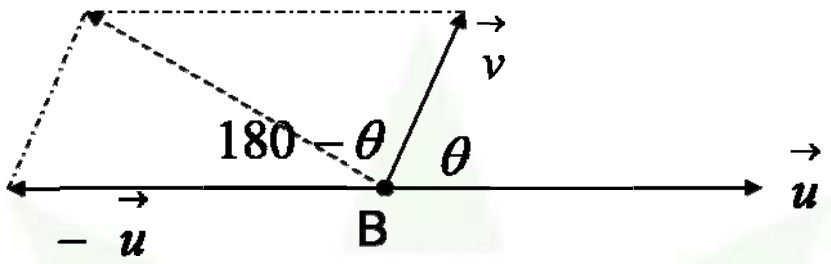
The two bodies are moving along any direction. Find relative velocity of B with respect to A



(1) Bring A at rest by adding



(2) Apply the same vector $-\vec{u}$ to the body B also. Find the resultant of the two vectors by means of vector law of parallelogram. The diagonal will represent the resultant.



Let θ = Angle between $\vec{u}$ & $\vec{v}$

$$R = \sqrt{u^2 + v^2 + 2uv\cos(180-\theta)}$$

$$R = \sqrt{u^2 + v^2 - 2uv\cos\theta}$$

$\vec{R}$ makes angle α with - $\vec{u}$

$$\therefore \tan\alpha = \frac{v\sin(180-\theta)}{u + v\cos(180-\theta)} = \frac{v\sin\theta}{u - v\cos\theta}$$