Chapter 6

Relative Motion

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RELATIVE MOTION

Relative is a most common word use to compare any property of any object with respect to other object "

$X_{AB} = X_A - X_B$,

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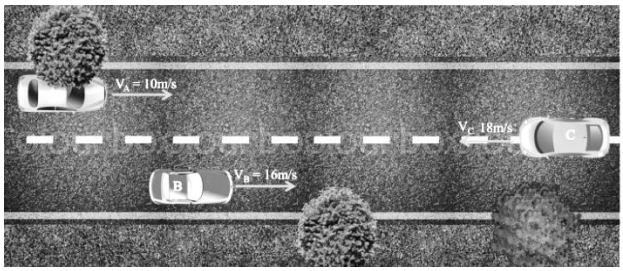
X of A with respect to B

Here x may be any physical or non physical quantity



Sign convention

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$V_{AB} = V_A - V_B$

$= + 10 - (16)$

$V_{AB} = -6$m/s , B says that it seems to be that car A is moving left with 6 m/s

But if $V_{BA} = V_B - V_A$

$= (16) - (+10)$

$V_{BA} = 6$m/s

A says that if seems to be that car B is moving right with 6 m/s

And if $V_{BC} = V_B - V_C$

$= (+16) - (-18)$

$= +34$ m/s

C says that it seems to be that car B is moving right with 34 m/s

Also $V_{CA} = V_C - V_A$

$= - 18 - (+10)$

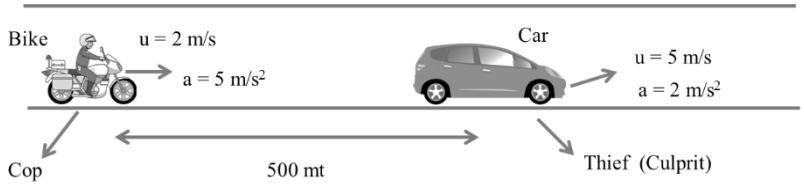
$= - 28$ m/s

A says that it seems to be that car C is moving left with 28 m/s

Applications and Understanding of relative motion

Case : 1 Catching, collision problem

As shown in figure a cop is chasing to a thief . After how long the cop will catch the thief?



Solution : First of all we will shift our frame on car so now everything will be relative to car

Initial velocity of car w.r. to bike $u_{CB} = u_C - u_B$

$= 5 - 2$

$u_{CB} = 3m/s$

Acceleration of car w.r. to bike $a_{CB} = a_C - a_B$

$= 2 - 5$

$= -3\ m/s^2$

Distance of car w.r. to bike $S_{CB} = S_C - S_B$

$= 0 - 500$

$= -500$ mt

Note : Here we are shifting our frame on car so it would be at rest

Now $S_{CB} = u_{CB}t + \frac{1}{2}a_{CB}t^2$

$-500 = 3t - \frac{1}{2} \times 3t^2$

$3t^2 - 6t - 100 = 0$, Now use dharacharya method

$t = \frac{6 \pm \sqrt{36+12000}}{2\times 3}$, neglect $-$ Sign

$t = \frac{6+\sqrt{12036}}{6} = \frac{6+109.7}{6} = \frac{115.7}{6} = 19.28\ \text{sec}$ Ans

Case II:- Lift or elevator in relative motion.

In this case it is given that boy is dropping a coin inside the lift at the same time lift also start moving down ward with acceleration 5 m/s^2, if height of coin from the flower is 10 meter. Then find. Time after which coin strike the floor of lift.

Solution: Here again first of all we will shift our frame inside the lift (or on the lift).

So now lift is assume to be at rest now.

Initial velocity of coin w.r. to lift $u_{cl} = u_c - u_l$

Because coins & lift start simultaneously = u – u = 0

Acceleration of coin w.r. to lift $a_{cl} = a_c - a_l$

Sign convention 

$= -g - 5$

$= -10 - 5$

$a_{cl} = -15 m/s^2$

distance covered by coin w.r to lift $h_{cl} = h_c - h_l$

$= -10 - 0$

$= -10$ meter

Now

$h_{cl} = u_{cl}t + \frac{1}{2}a_{cl}t^2 \qquad -10 = 0 + \frac{1}{2}(-15)t^2$

$\frac{20}{15} = t^2 \Rightarrow t = \sqrt{\frac{20}{15}}\ \text{sec}$