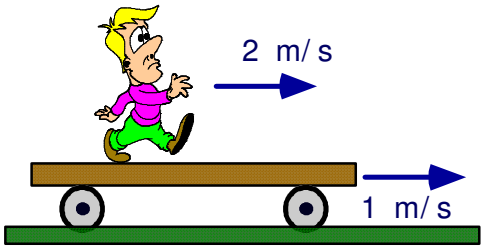
Unit 3: Kinematics in 2D

1 - Relative Velocity

In order to properly describe an object's motion we need to know... its frame of reference. (point of view)

Example: A man walks to the right with a velocity of 2 m/s on a platform that moves with a velocity of 1 m/s to the right.



a) What is the person's velocity relative to the platform?

Reference frame: platform

$v_{person\text{-}platform}$ = 2 m/s

b) What is the person's velocity relative to the ground?

Reference frame: ground

$v_{person\text{-}ground} = v_{platform} + v_{person\text{-}platform}$

$v_{person\text{-}ground}$ = 1 m/s + 2 m/s

$v_{person\text{-}ground}$ = 3 m/s

Example: You can throw a pie at 32 m/s. If you are standing on a train traveling 32 m/s east and throw a pie forward what is its resultant (total) velocity?

$V_{train} = 32\ m/s$ $V_{pie} = 32\ m/s$

$V_{total} = 64\ m/s$

Example: A bowling team on a train heads **east** at 15 m/s. A stationary observer watches them play as they pass. At what velocity would the following throws appear to be moving at?

Biff: Throws @ 12 m/s East

$V_{train} = 15\ m/s$ $V_{Biff} = 12\ m/s$

$V_{total} = 27\ m/s$

Hank: Throws @ 18 m/s East

$V_{train} = 15\ m/s$ $V_{Hank} = 18\ m/s$

$V_{total} = 33\ m/s$

Ralph: Throws @ 15 m/s West

$V_{train} = 15\ m/s$

$V_{Ralph} = 15\ m/s$ $V_{total} = 0$

Train A leaves Vancouver station traveling east at 90. km/h at 9:00 am. At the same time train B leaves Montreal traveling west at 110 km/h. If the two stations are 4800 km.

a. At what time do they meet?

$V_{rel} = 90\ km/h + 110\ km/h = 200\ km/h$

$V = \frac{d}{t}$ $t = \frac{d}{V} = \frac{4800\ km}{200\ km/h} = 24\ h$

b. Where are they when they meet?

$V_A = \frac{d_A}{t}$ $d_A = V_A t = (90\ km/h)(24\ h)$

$= 2160\ km$ E of Vancouver

If the conductor of train A notices that is takes exactly 3.2 s for train B to pass it, what is the length of train B?

$V_{rel} = 200\ km/h \div 3.6$

$= 55.56\ m/s$

$d = V \cdot t$

$= (55.56\ m/s)(3.2\ s)$

$= 180\ m$