Relative Motion: 2D Velocity & 'River Questions'

COLLINEAR : Let's say you can walk comfortably at 1.5 m/s [fwd]. But let's say you get on a bus and sit down. The bus is moving at 20 m/s [fwd]. To an observer on the sidewalk both you (sitting down) and the bus are moving at 20 m/s [fwd]. But let's say you see your stop coming so you get up and move towards the front of the bus, as its moving. Now according to the observer on the sidewalk, you are moving 21.5 m/s [fwd] ie: 20 + 1.5 = 21.5 m/s [fwd].

Although that may be logical, it would be helpful to know how to get that answer mathematically. We are adding non-collinear vectors. Set [forward] as positive so you have

+20 + (+1.5) = +20.5 m/s [fwd].

If you were walking to the back of the bus as it was moving, then your final velocity (according to the observer on the sidewalk) is

+20 +(-1.5) = +18.5 m/s [fwd]

Now think carefully: If you had an observer sitting on the moving bus with you, what your velocity appear to be when:

a) you are sitting v = _____________ b) you are walking 1.5 m/s [fwd] __________

c) you are walking 1.5 m/s [bkwd]_______________

NON-COLLINEAR: OK – so we can add collinear velocity vectors as integers just like we added collinear displacement vectors as integers. Let's apply the same concept to 2D velocity. When we add non-collinear vectors, we have to use Pythagorean and SOH CAH TOA to solve.

Let's say the airspeed of a small plane is 200 km/h . If it heads due north and there is a wind blowing at 50 km/h [E], what is its resultant velocity? (ie: if there was an observer on the ground, what velocity – magnitude and direction – would the plane have).

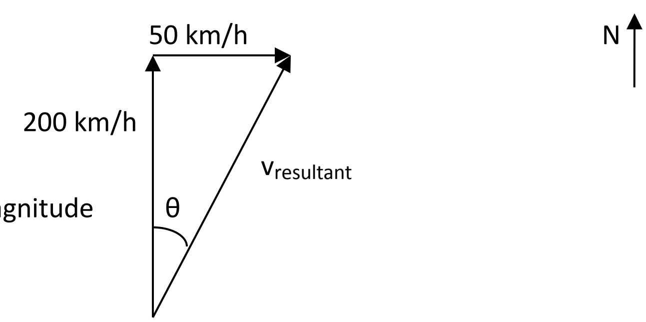
G: v_{plane} = 200 km/h [N], v_{wind} = 50 km/h [E]

R: $v_{resultant}$

A: add the 2 velocities graphically

S: see diagram

Use Pythagorean theory to solve for magnitude of the plane's velocity.



Use SOH CAH TOA to solve for the angle. Check answers tomorrow!

'River Questions' are the classic way to ask about relative motion. The swimmer has a set speed (just like the airplane) and the river has a current that moves perpendicular to the swimmer (like the wind speed). The motion of the swimmer relative to an observer on shore is the SUM of the TWO SPEED VECTORS