Name: _______________________________ Phys 12

2.3 Relative Velocity and Navigation

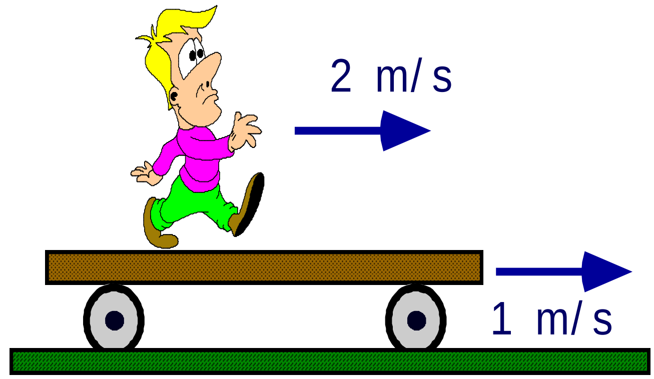
Review: Last class we looked at vector addition in 2D where 2 vectors contributed to the motion of an object. This lesson will look at more of these examples.

Before looking at relative velocity, we need to discuss Reference frames.

A Reference frame is a set of coordinate axis of which we will analyze position and motion.

What happens when one reference frame is within another reference frame?

Ex 1: 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

"relative to"

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

Reference frame: ground

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

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

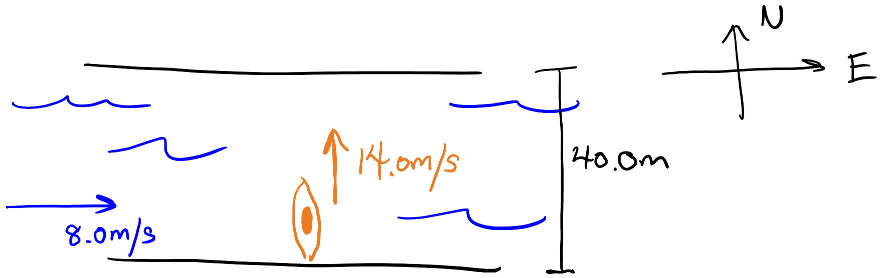
$v_{person\text{-}ground}$ = 3 m/s

Notice that the platform reference frame canceled out in our equation in their respective locations to give us the velocity of the person relative to the ground.

What if the person was a canoe, the platform was a moving river, and we're dealing with a 2D problem?

Ex 2: A student in a canoe is trying to cross a 40.0 m wide river that flows to the east at 8.0 m/s. The student can paddle at 14.0 m/s.

Draw a picture:

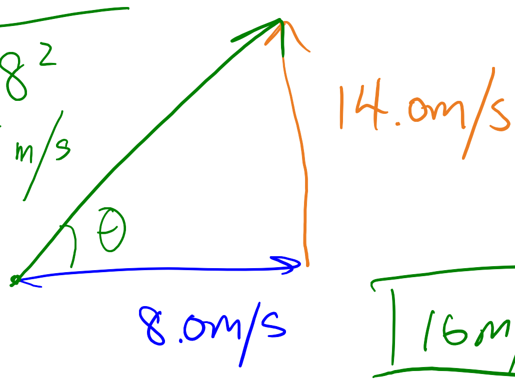


a) Will the canoe travel in a straight line going North if the student paddles North?

b) If he points due north and paddles, what will be his resultant velocity?

$R_T = \sqrt{14^2 + 8^2}$

$= 16.1245..\ m/s$



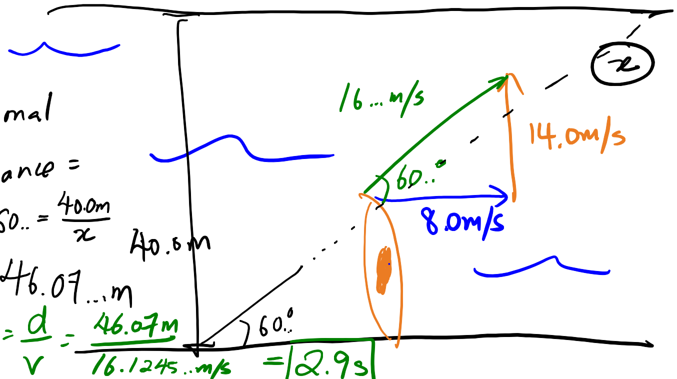
$\tan\theta = \frac{14.0\ m/s}{8.0\ m/s}$

$\theta = 60.255...^\circ$

16 m/s @ 60.° North of East

c) How long will it take him to cross?

2 solutions →



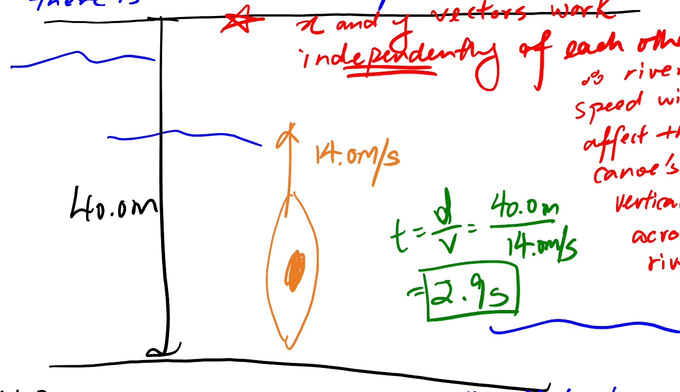
diagonal distance = $\sin 60.. = \frac{40.0m}{x}$

$x = 46.07...m$

$\therefore t = \frac{d}{v} = \frac{46.07m}{16.1245..m/s} = \boxed{2.9s}$

there is an easier way...

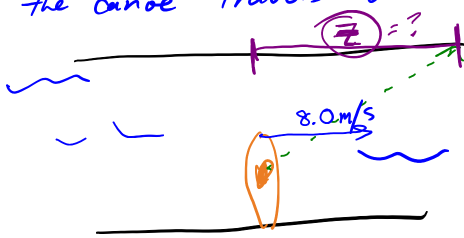
☆ x and y vectors work independently of each other! ∴ river speed will NOT affect the canoe's vertical speed across the river.



$t = \frac{d}{v} = \frac{40.0m}{14.0m/s} = \boxed{2.9s}$

d) How far downstream will he land when he gets to the other side?

again... you could use trig, but only the river's horizontal speed will affect how far the canoe travels downstream.



$z = vt$

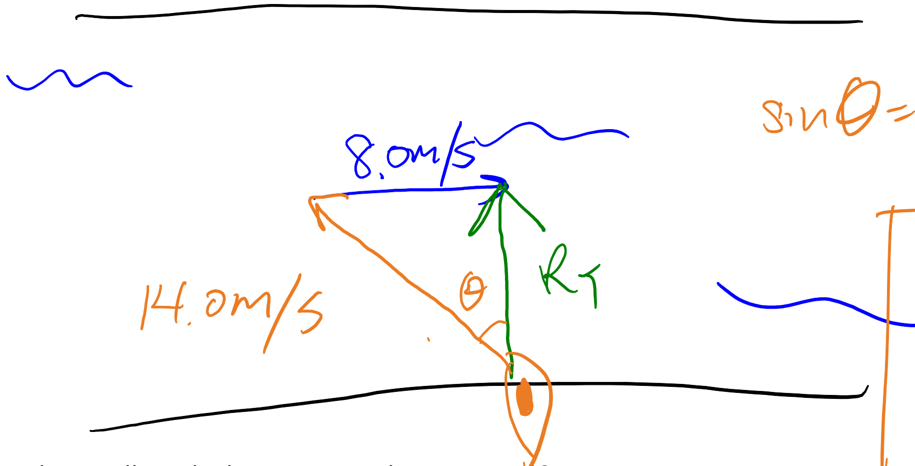
$= 8.0(2.85..s)$

$= \boxed{23\ m}$

☆ time it takes the canoe to cross in still water ($v_R = 0$) is the same as the time it takes the canoe to cross moving water ($v_R = 8.0m/s$)

☆ time for vertical motion = time for horizontal motion

e) How should he paddle so that he moves in a straight line across the river going North? At what angle should he point his canoe?



$\sin\theta = \frac{8.0m/s}{14.0m/s}$

$\boxed{\theta = 35° \text{ West of North}}$

f) How long will it take him to cross the river in e)?

* vertical component → R_T

$R_T = \sqrt{14^2 - 8^2} = 11.489...m/s$

$t = \frac{d}{v} = \frac{40.0m}{11.489..m/s} = \boxed{3.5s}$

HW: The Across the River Problem (#1), Vector Problems (#4-10), Vector Problems section 2 (#1-6)