Phy 2A 4/19

Wednesday, April 19, 2017 9:36 AM

Goals for the Lecture:

1) Be able to solve 2-D kinematics problems (constant acceleration)
2) Be able to solve velocity addition problems

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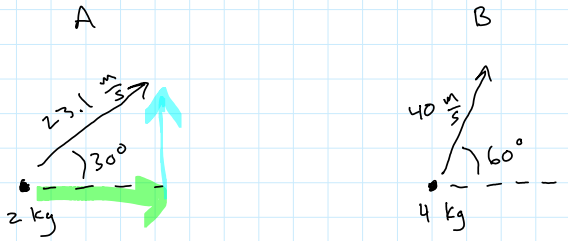
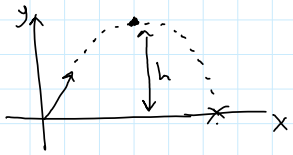
2 cannons:



	A	B
1) find $(V_x)_i$	$V_i \cos\theta = 23.1 \cos 30^\circ = 20 \frac{m}{s}$	$40 \cos 60^\circ = 20 \frac{m}{s}$
2) find $(V_y)_i$	$V_i \sin\theta = 11.6 \frac{m}{s}$	$34.6 \frac{m}{s}$
3) Find max. height		

For A:

y_i	0
y_f	h
V_{iy}	11.6 m/s
V_{fy}	0
a_y	$-9.8 \frac{m}{s^2}$
t	X



$y_f = y_i + V_{iy} t + \frac{1}{2} a_y t^2$

$V_f^2 = V_i^2 + 2 a \Delta y$

$V_f = V_i + a t$

$V_f^2 = V_i^2 + 2 a \Delta y$

$0 = (11.6)^2 + 2(-9.8)(h - 0)$

$h = 6.87 \text{ m}$

4) Find velocity at top of path (highest point)

$$\left(\vec{V}_A\right)_{\text{at top}} = 20 \frac{m}{s} \hat{x} + 0 \hat{y}$$

5) find acceleration at top of path:

$$\vec{a} = 0 \hat{x} - 9.8 \hat{y}$$ + ↑ →+

6) find total time in air:

use y-motion to get time

Find time to top:

$$v_{fy} = v_{iy} + at$$

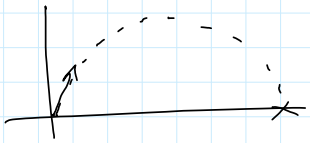
$$0 = 11.6 - 9.8\,t$$

$t = 1.18$ s to get to max. height

total time in air $= 2(1.18) = 2.36$ s

OR

y_i	0
y_f	0
v_{iy}	11.6
v_{fy}	
a	-9.8
t	



$$y_f = y_i + v_{iy}t + \frac{1}{2}a_y t^2$$

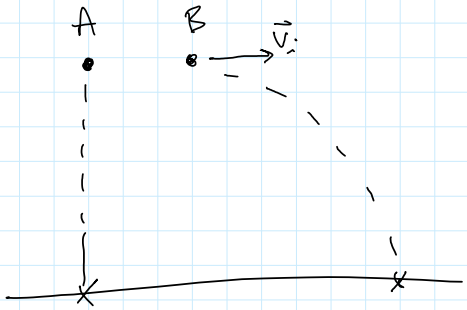
should get $t = 2.36$ s

7) how far did it travel in the x direction?

$$x_f = \cancel{x_i}^{\,0} + v_{ix}t + \frac{1}{2}\cancel{a_x}^{\,0}t^2$$

$$x_f = v_{ix}t = (20)(2.36) = 47.2 \text{ m}$$

Demo:



Which hits the ground first?

A) A hits first

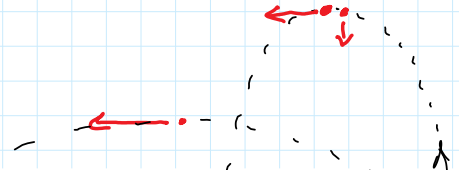
B) B hits first

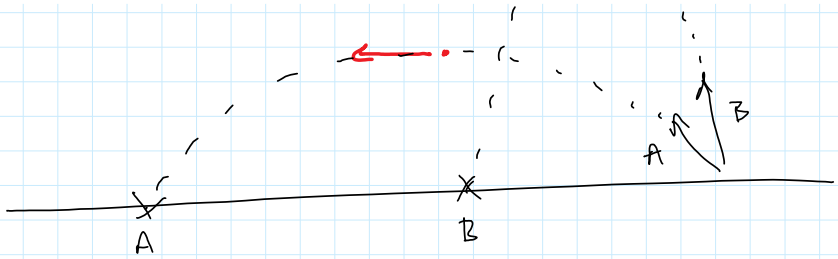
C) same time

D) Need more info

time determined by y-motion

Demo





which hits the ground first?

A) A

B) B

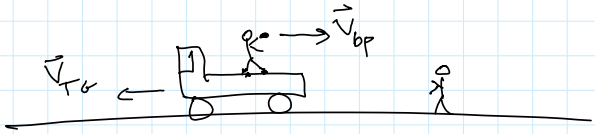
C) Same

D) Need more info

time determined by y-motion

Velocity addition

$\vec{V}_{bp}$ velocity of ball WRT person



Velocity of truck WRT ground

$\vec{V}_{bG}$ = Velocity of ball WRT ground = ?

$V_{bp} = 20 \frac{m}{s} \rightarrow$

$V_{TG} = 10 \frac{m}{s} \leftarrow$

$V_{bG} = 10 \frac{m}{s} \rightarrow$

If $V_{bp} = 20 \frac{m}{s} \rightarrow$

$V_{TG} = 10 \frac{m}{s} \rightarrow$

$V_{bG} = 30 \frac{m}{s} \rightarrow$

Plane in wind:

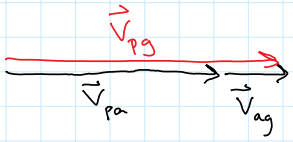
$\vec{V}_{pa}$ = velocity of plane WRT air

$\vec{V}_{ag}$ = " " air WRT ground

$\vec{V}_{pg}$ = " " plane " ground

1) $\vec{V}_{pa}$ = 300 mph due East

$\vec{V}_{ag}$ = 100 mph due east



V_{pg} = 300 + 100 = 400 mph due East

2) $\vec{V}_{pa}$ = 300 mph due East

$\vec{V}_{ag}$ = 100 mph due North

$\vec{V}_{pg}$ = ?

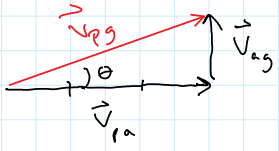
Velocity addition:

$$\vec{V}_{ac} = \vec{V}_{ab} + \vec{V}_{bc}$$

same

$$\vec{V}_{pg} = \vec{V}_{pa} + \vec{V}_{ag}$$

same

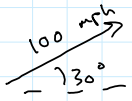


$V_{pg} = \sqrt{300^2 + 100^2}$ = 316 mph

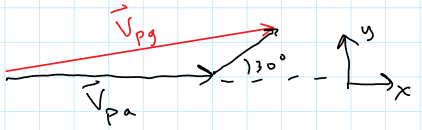
$\theta = \tan^{-1}\left(\frac{100}{300}\right)$ = 18.4°

3) $\vec{V}_{pa}$ = 300 mph due East

$\vec{V}_{ag}$ = 100 mph 30° N of E



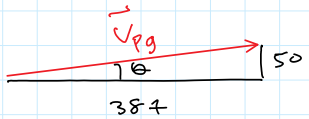
use components:



use Components:

	x	y
$\vec{V}_{pa}$	300	0
$\vec{V}_{ag}$	87	50
	387	50

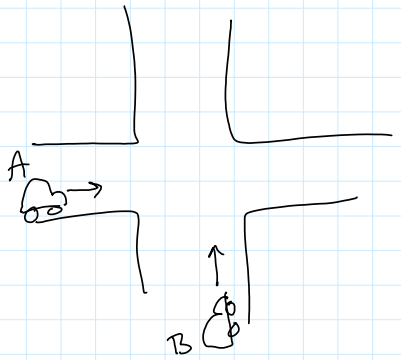
$$\vec{V}_{pg} = \vec{V}_{pa} + \vec{V}_{ag}$$



$$V_{pg} = \sqrt{387^2 + 50^2} = 390 \text{ mph}$$

$$\theta = \tan^{-1}\left(\frac{50}{387}\right) = 7.36^\circ$$

4) 2 cars



$\vec{V}_{Ag}$ = velocity of car A WRT ground = 50 mph due E

$\vec{V}_{Bg}$ = " " " B " " = 40 mph due N

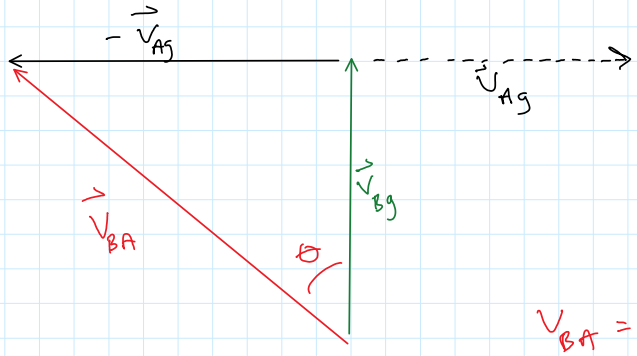
$\vec{V}_{BA}$ = " " " B ↔ car A = ?

we expect the answer to be:

$$\vec{V}_{BA} = \vec{V}_{Bg} + \vec{V}_{gA} = \vec{V}_{Bg} + \left(-\vec{V}_{Ag}\right)$$

same

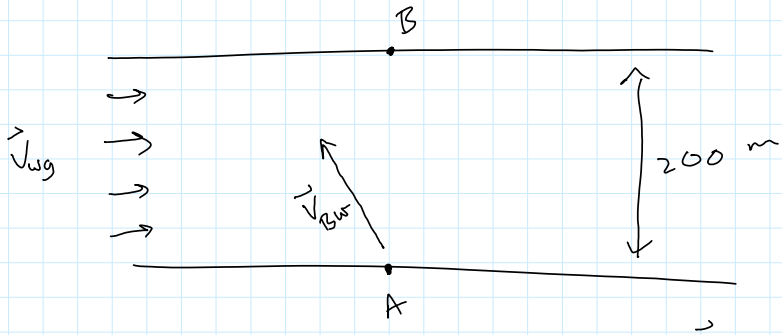
since $\vec{V}_{Ag} = -\vec{V}_{gA}$

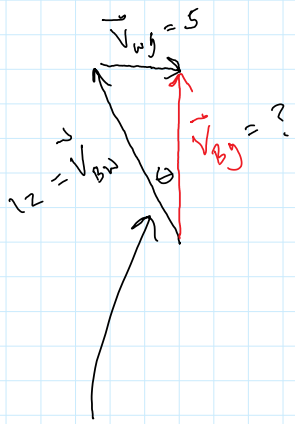


$$V_{BA} = \sqrt{40^2 + 50^2}$$

$$\theta = \tan^{-1}\left(\frac{50}{40}\right)$$

Cross a river: leave A, want to get to B
a) what angle do you point your boat b) how long does it take





$\vec{V}_{BW}$ = velocity of boat wrt water = 12 $\frac{m}{s}$

$\vec{V}_{wg}$ = " " water " ground = 5 $\frac{m}{s}$

$\vec{V}_{bg}$ = " " boat " ground

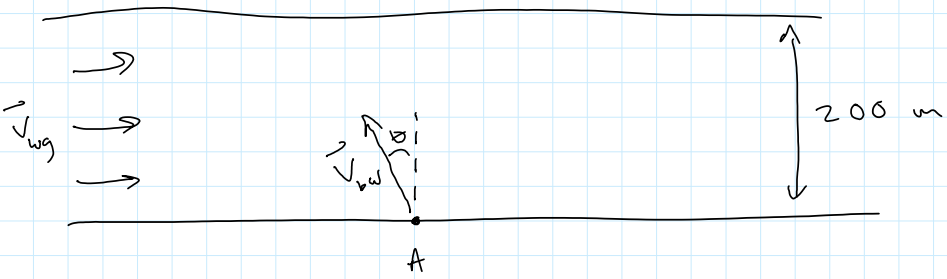
$$\vec{V}_{Bg} = \vec{V}_{BW} + \vec{V}_{wg}$$

$$\theta = \sin^{-1}\left(\frac{5}{12}\right) = 24.6^\circ$$

$$V_{Bg} = \sqrt{12^2 - 5^2} = 10.9 \frac{m}{s}$$

$$\text{time} = \frac{\text{distance}}{\text{velocity}} = \frac{200 \text{ m}}{10.9 \frac{m}{s}} = 18.3 \text{ s}$$

Cross a river



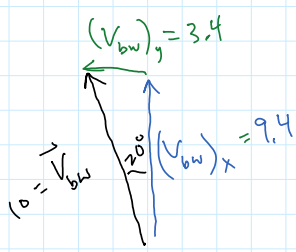
$\vec{V}_{bw} = 10 \frac{m}{s}$, $\theta = 20°$ up stream

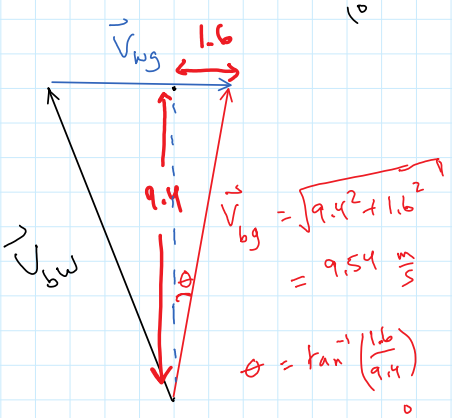
$\vec{V}_{wg} = 5 \frac{m}{s} \rightarrow$

find a) where you land on the other side of the river?

b) how long it takes to cross?

$\vec{V}_{bg} = \vec{V}_{bw} + \vec{V}_{wg}$





$\vec{V}_{bg} = \sqrt{9.4^2 + 1.6^2}$

$= 9.54 \frac{m}{s}$

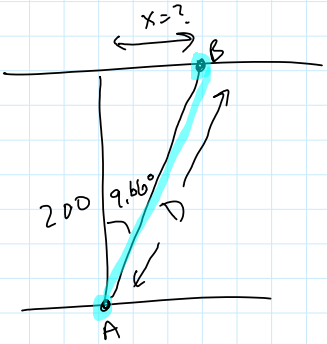
$\theta = \tan^{-1}\left(\frac{1.6}{9.4}\right)$

$\theta = 9.66°$

use components

	x	y
$\vec{V}_{bw}$	−3.4	9.4
$\vec{V}_{wg}$	5	0
$\vec{V}_{bg}$	1.6	9.4

a)



$x = 200 \tan 9.66°$

$= 34.0$ m

$D = \frac{200}{\cos 9.66°} = 203$ m

b) time $= \frac{\text{distance}}{\text{velocity}} = \frac{200 \text{ m}}{9.4 \frac{m}{s}} = 21.3$ s ← distance in y direction

$$\text{velocity} = \frac{\qquad}{9.4\ \frac{m}{s}} = \text{[illegible]}$$

↑ velocity in y direction

all should give the same time

OR

$$\text{time} = \frac{\text{distance}}{\text{velocity}} = \frac{203\ m}{9.54\ \frac{m}{s}} = 21.3\ s$$

← distance actually traveled from A to B

↑ velocity in the actual direction traveled from A to B

OR

$$\text{time} = \frac{34.0\ m}{1.6\ \frac{m}{s}} = 21.3\ s$$

← distance traveled in the x direction

↑ velocity in the x direction