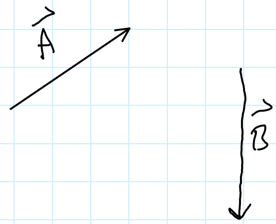
Phy 2A 4/17

Monday, April 17, 2017 9:41 AM

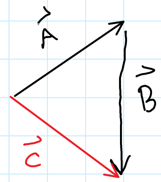
Goals for the Lecture:

1) Be able to add vectors graphically and using components (trig functions)
2) Begin solving 2-D kinematics problems

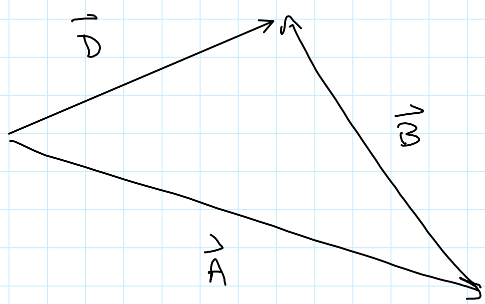
Add vectors : Tip to tail



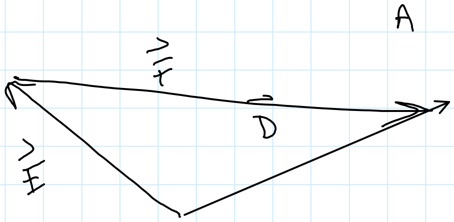
Find $\vec{C}$ if $\vec{C} = \vec{A} + \vec{B}$



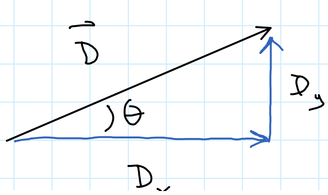
Find 2 vectors that add to $\vec{D}$:



$\vec{D} = \vec{A} + \vec{B}$

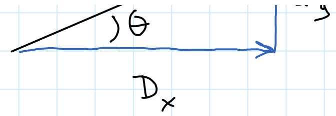


$\vec{D} = \vec{E} + \vec{F}$



$\vec{D} = \vec{D}_x + \vec{D}_y$

$D_x = D \cos\theta$

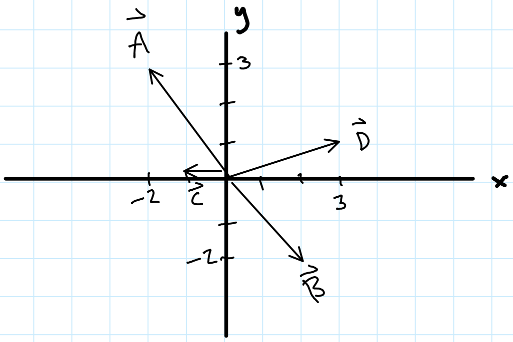


$D_x = D\cos\theta$

$D_y = D\sin\theta$

$\tan\theta = \dfrac{D_y}{D_x}$

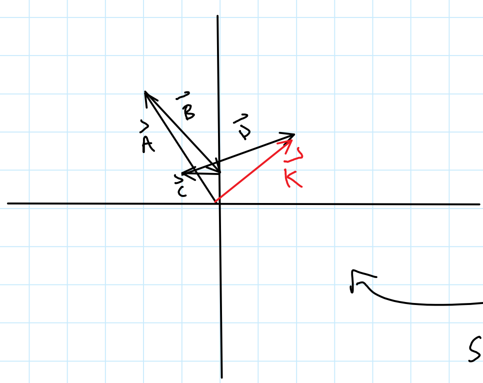
Find x and y components of each:



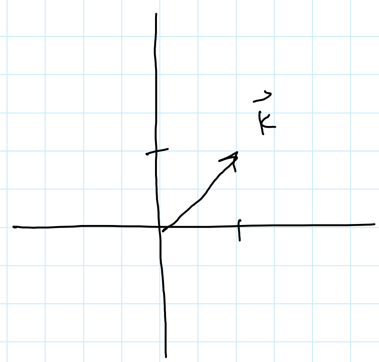
	x-comp	y-comp
A	-2	3
B	2	-2
C	-1	0
D	3	1
	2	2
	$\uparrow$ K_x	$\uparrow$ K_y

Find $\vec{K} = \vec{A} + \vec{B} + \vec{C} + \vec{D}$

vector addition

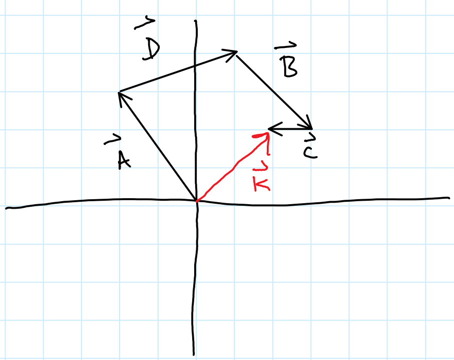


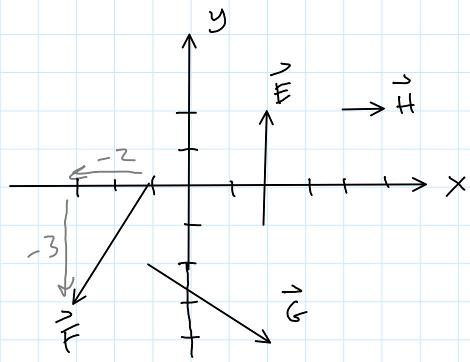
use components:



same

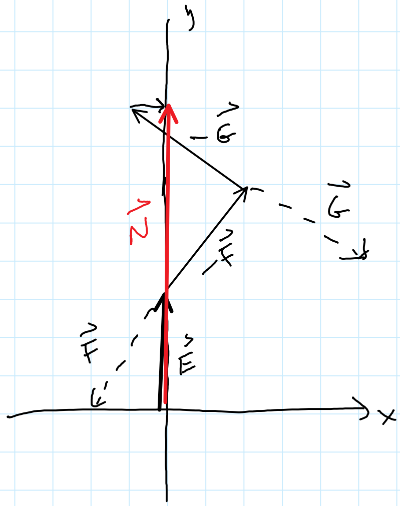
in a different order it is easier to see:





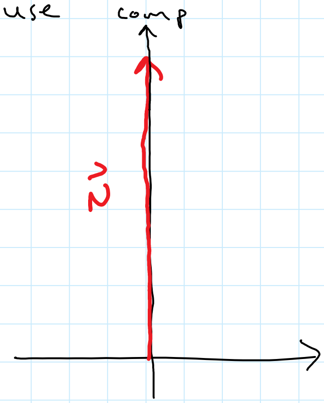
	x-comp	y-comp
E	0	3
F	−2	−3
G	3	−2
H	1	0
N	$\underbrace{0 - (-2) - 3 + 1}_{0}$	$\underbrace{3 - (-3) - (-2) + 0}_{8}$

Find $\vec N = \vec E - \vec F - \vec G + \vec H$



$\Downarrow$

use comp



$\vec N = 0\,\hat x + 8\,\hat y$

or

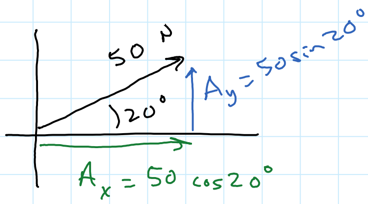
$\vec N = 0\,\hat\imath + 8\,\hat\jmath$

$-8 \frac{m}{s}$ $\uparrow +$

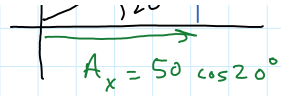
$8 \frac{m}{s}$ downward

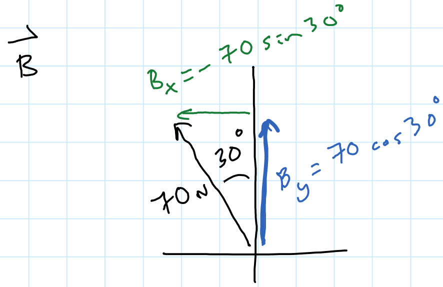
Add these 3 vectors: $\vec D = \vec A + \vec B + \vec C$

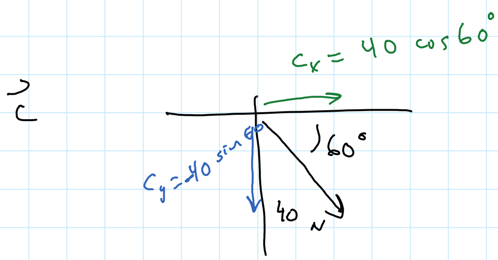
$\vec A$



	x-comp	y-comp
A	$50 \cos 20° = 47.0$	$50 \sin 20° = 17.1$
B	$-70 \sin 30°$	$70 \cos 30° = 60.6$

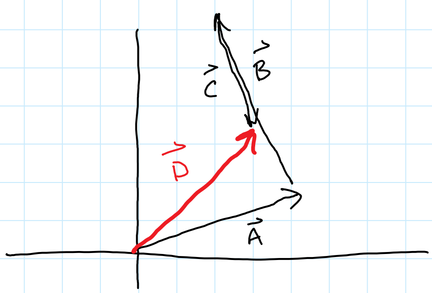




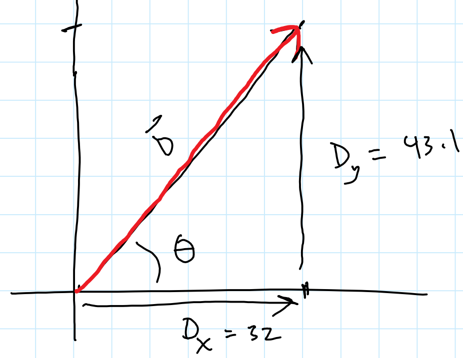


	= 47.0	
B	$-70 \sin 30°$ = −35.0	$70 \cos 30° = 60.6$
C	$40 \cos 60°$ = 20.0	$-40 \sin 60° = -34.6$
D	47 + (−35) + 20 = 32	17.1 + 60.6 − 34.6 = 43.1

quick check using graphical vector addition:



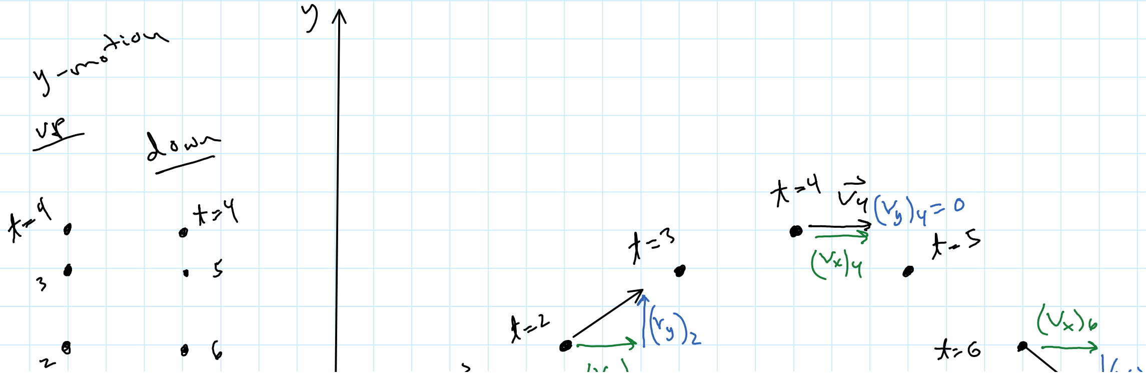
using components

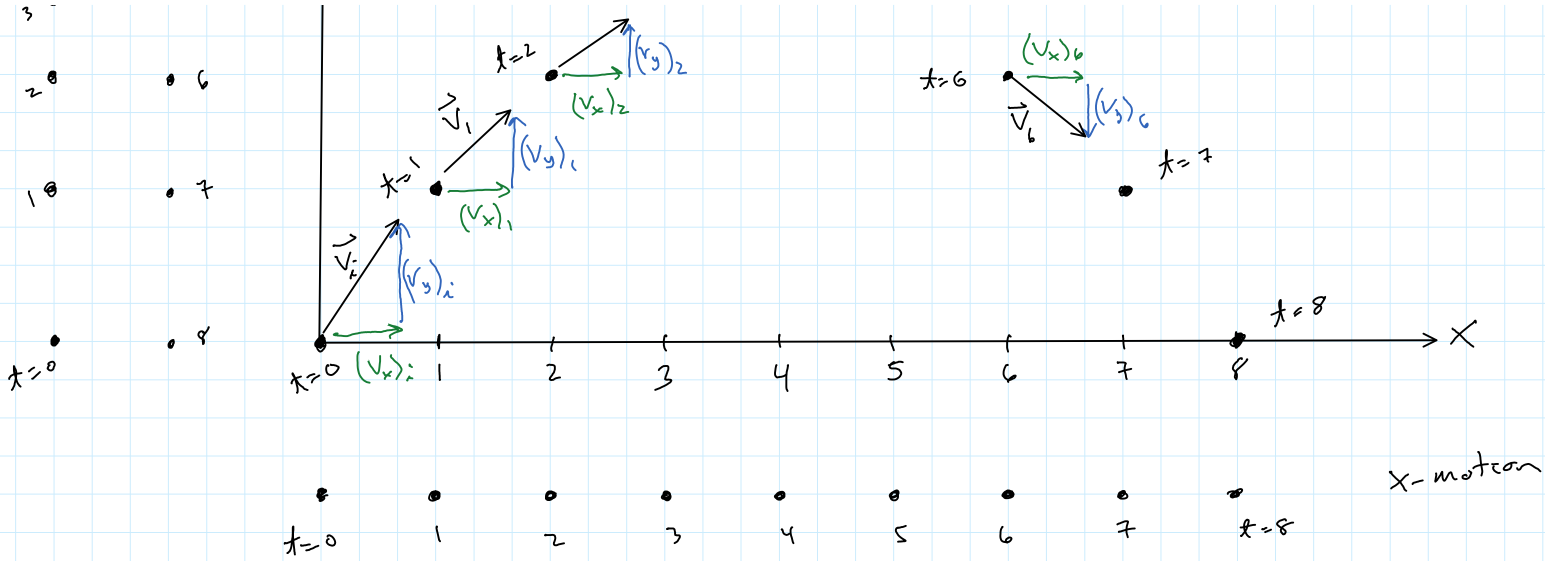


$$D = \sqrt{32^2 + 43.1^2} = 53.7 \text{ N}$$

$$\theta = \tan^{-1} \frac{43.1}{32} = 53.4°$$

2-D Kinematics





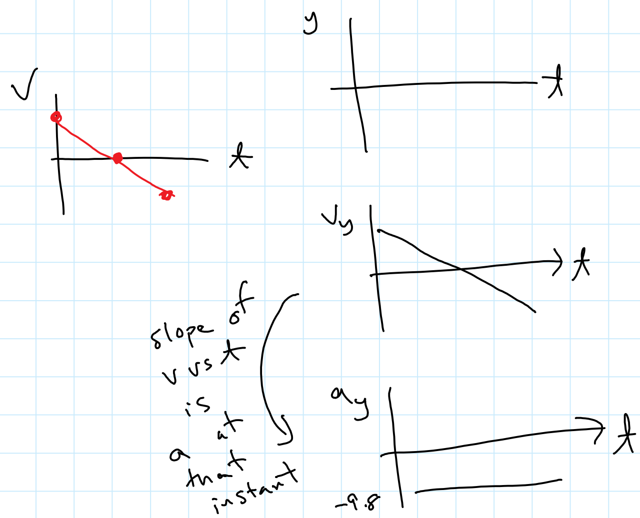
worksheet p. 73

i) A

ii) C

iii) I

iv) B



worksheet p. 82

a) $(V_x)_A < (V_x)_B$

b) $(V_y)_A = (V_y)_B$

c) $(a_x)_A = (a_x)_B = 0$

d) $(a_y)_A = (a_y)_B = 9.8 \frac{m}{s^2}$

Application of the Day:

MLBAM introduces new way to analyze every play

Jason Heyward's spectacular game-ending catch against the Mets through the eyes of

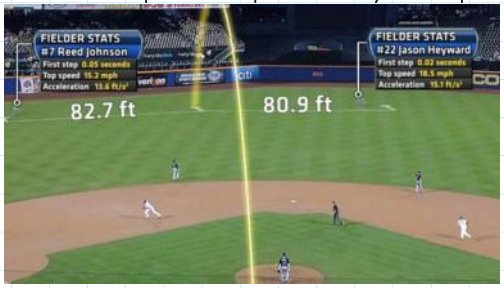
By Mark Newman / MLB.com | March 1st, 2014

Major League Baseball Advanced Media on Saturday introduced a revolutionary plan for in-ballpark infrastructure designed to provide the first complete and reliable measurement of every play on the field and answer previously unanswerable analytics questions.

The goal is to revolutionize the way people evaluate baseball, by presenting for the first time the tools that connect all actions that happen on a field to determine how they work together. This new datastream will enable the industry to understand the whole play on the field -- batting, pitching, fielding and baserunning -- and enable new metrics for evaluation by clubs, scouts, players and fans.

For instance, on a brilliant, game-saving diving catch by an outfielder, this new system will let us understand what created that outcome. Was it the quickness of his first step, his acceleration? Was it his initial positioning? What if the pitcher had thrown a different pitch? Everything will be connected for the first time, providing a tool for answers to questions like this and more.

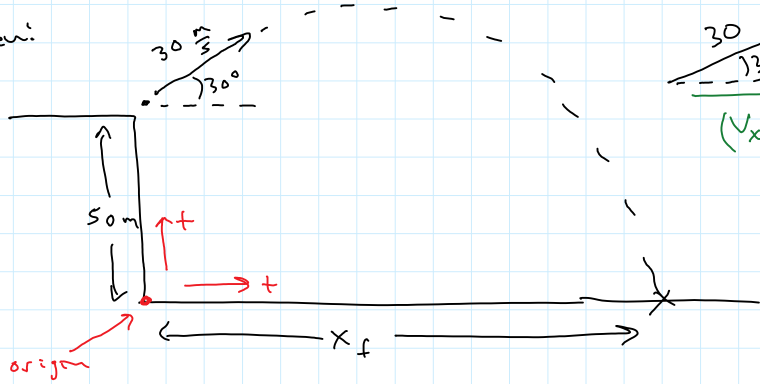
There will be something for everyone, far beyond what has been available in the past. Miller Park in Milwaukee, Target Field in Minnesota and Citi Field in New York will be operational for this tracking in 2014. The plan is to start rolling out the rest this season so that all 30 ballparks are operational by 2015 Opening Day.

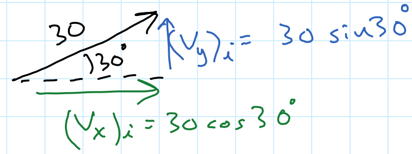


It tracks the speed and efficiency of fielders, based on highly accurate readings on hit balls—batted ball speed, launch angle, distance, hang time—and then how fast and how well the defenders react, capturing 30 frames per second on players and 2000 fps on the ball. It's the Holy Grail, basically.
The cameras went through a pilot test last year at Citi Field, and track the trajectory and speed of a ball, and show the path it takes. Simultaneously, they recognize where defenders are on the field, and how far they are from where the ball will land; it then tracks their actual paths, and how optimal they were. One of the examples used was a fly ball hit to left-center: Jason Heyward tracked it and caught it, running at a top speed of over 18 miles per hour, accelerating at 15.1 feet per second, and taking a path that took 83.2 feet, compared to the 80.9-foot optimal path. This is a 97 percent-efficient path, and was far faster than that of the left fielder, whose stats we also see. (Also tracked: reaction time, which is both useful and cool.) This will happen for every single ball put into play.

Example

given:





find x_f and t

1st) define origin and positive directions

2nd) fill in the tables

x-motion

x_i	0
x_f	x_f
v_{ix}	$+30 \cos 30 = 26\ \frac{m}{s}$
v_{fx}	same $26\ \frac{m}{s}$
a_x	0
t	?

y-motion

y_i	+50 m
y_f	0
V_{iy}	$+30 \sin 30 = 15\ \frac{m}{s}$
V_{fy}	X
a_y	$-9.8\ \frac{m}{s^2}$
t	?

same

use y-motion to get t

use that t in x-motion to get x_f

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

$$0 = 50 + (15) t + \frac{1}{2}(-9.8)\, t^2$$

$$t = \begin{cases} -2.01\ s \\ +5.07\ s \end{cases}$$

$t = 5.07\ s$ (must be positive)

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

$$x_f = 0 + (26)(5.07) = 131.8 \text{ m}$$