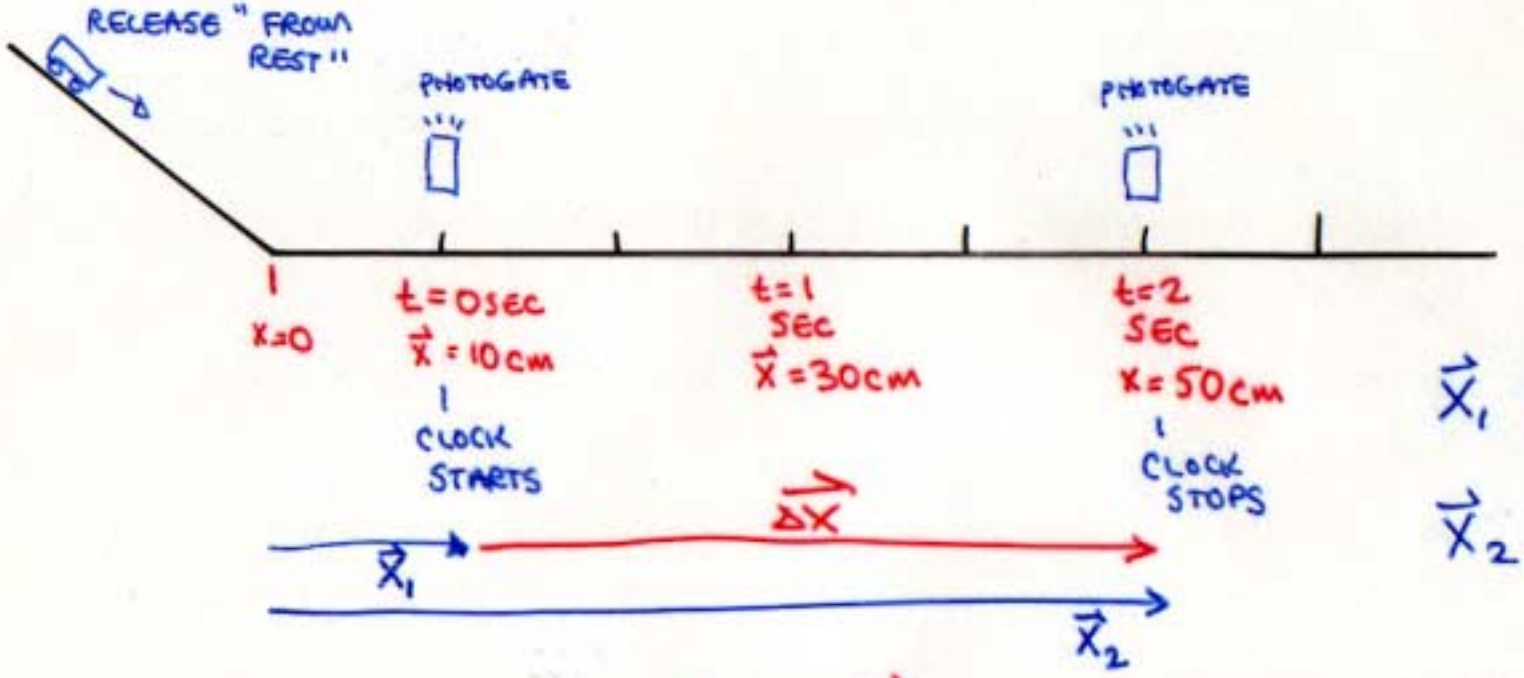
☐ MOTION ... POSITIONS CHANGING OVER TIME

8-B



$\vec{x}_1$ POSITION AT "START"

$\vec{x}_2$ POSITION AT "END"

AVERAGE VELOCITY: $\vec{v} = \frac{\vec{\Delta x}}{\Delta t}$ – IT IS A VECTOR, TOO!

DEFINITION

$= \frac{\text{"DISPLACEMENT FROM } X_1 \text{ TO } X_2\text{"}}{\text{"CHANGE IN TIME FROM START TO FINISH"}}$

NOT JUST "HOW FAR DID YOU GO, IN WHAT TIME"... DIRECTION IS IMPORTANT.

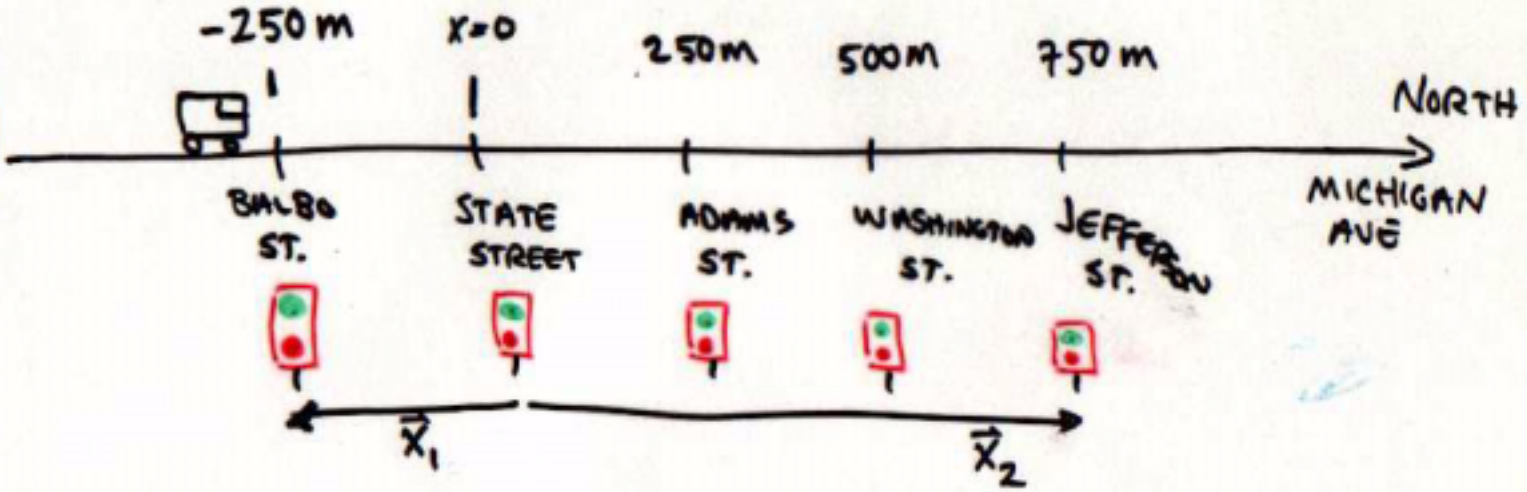
$$\vec{v} = \frac{\vec{\Delta x}}{\Delta t} = \frac{(+50\,\text{cm} - 10\,\text{cm})}{2\,\text{SEC}} = \frac{40\,\text{cm}}{2\,\text{SEC}} = 20\ \frac{\text{cm}}{\text{SEC}}$$

NUMBER UNITS.

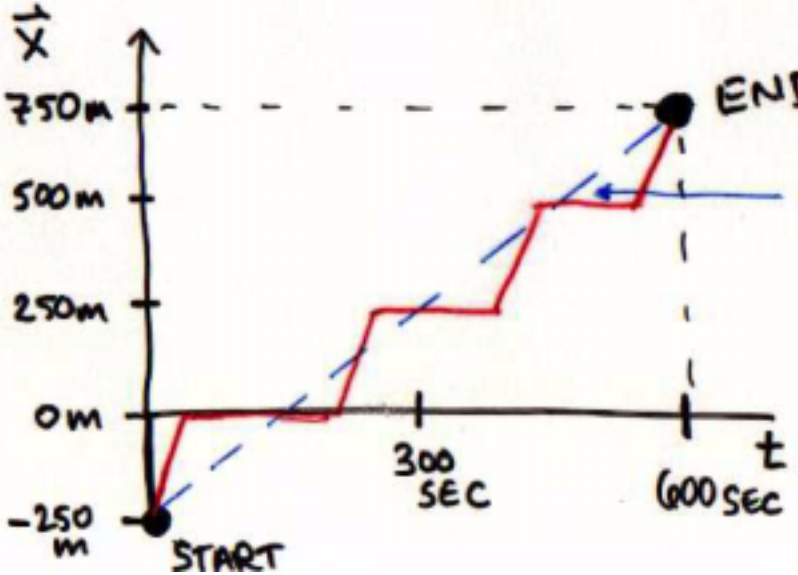
AVERAGE vs. INSTANTANEOUS ("EXACT") VELOCITY ... 8.9 ⇔ 8-11

CHICAGO – MICHIGAN AVENUE – DOWNTOWN.

1000M / 10MIN ≈ 6KM / HOUR!



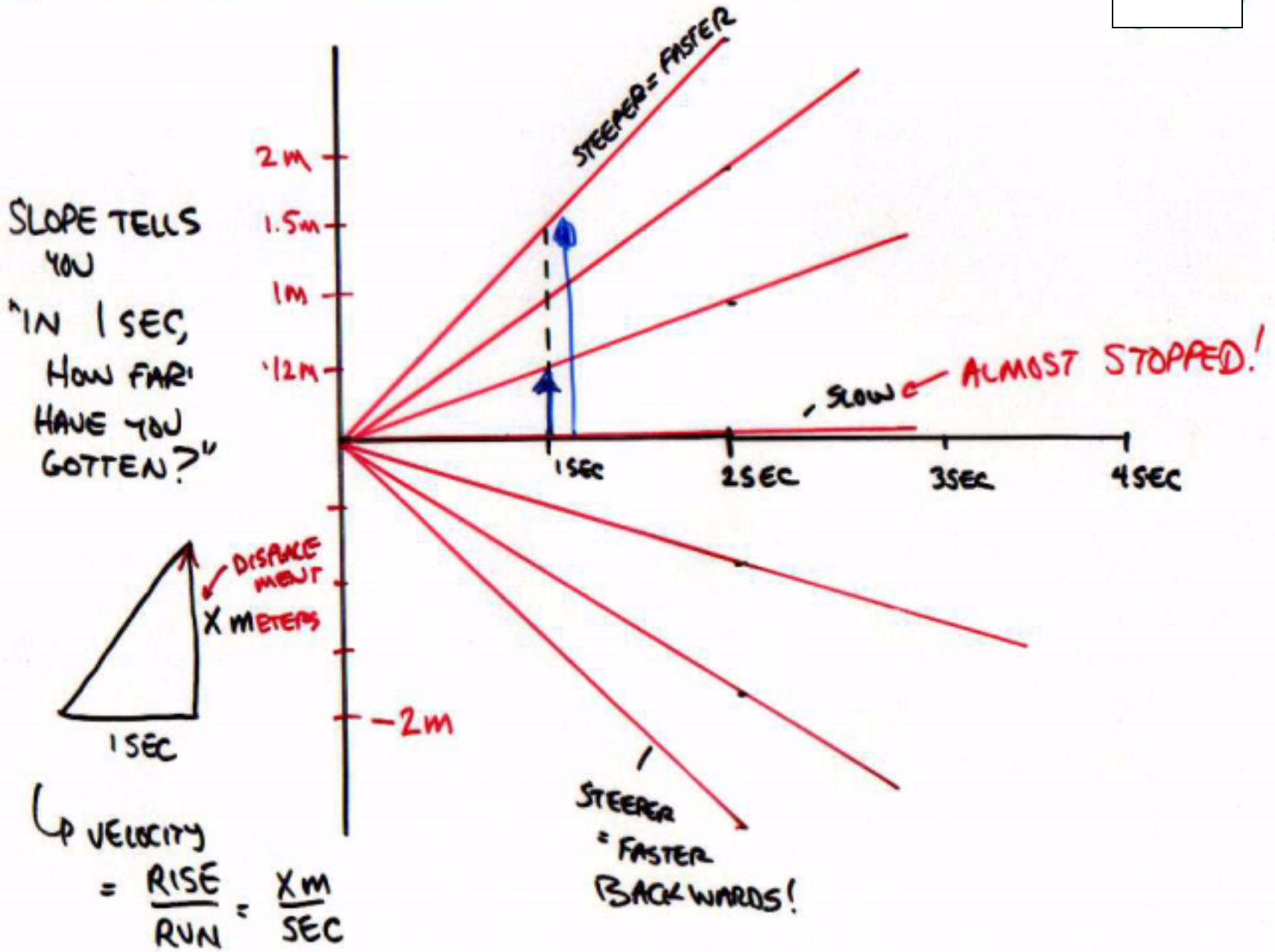
YOU GO FROM BALBO UP TO JEFF. ST. IN HEAVY TRAFFIC.
10 MINUTES = 600 SEC.



IF YOU COAST THROUGH ALL THE LIGHTS + NEVER HAVE TO BRAKE.

BUT – WHAT REALLY HAPPENS?

EXAMPLES SLOPE AND VELOCITY



SLOPE TELLS YOU "IN 1 SEC, HOW FAR HAVE YOU GOTTEN?"

↳ VELOCITY = $\frac{\text{RISE}}{\text{RUN}} = \frac{X\text{M}}{\text{SEC}}$

☐ ACCELERATION

NOT ONLY DOES POSITION CHANGE IN TIME,
SO, TOO DOES VELOCITY

$$\vec{a} = \text{"ACCELERATION"} = \frac{\vec{v}_2 - \vec{v}_1}{t_2 - t_1} = \frac{\Delta \vec{v}}{\Delta t}$$

EXACTLY SHADOWS "VELOCITY"

$$\vec{v} = \text{"VELOCITY"} = \frac{\vec{x}_2 - \vec{x}_1}{t_2 - t_1} = \frac{\Delta \vec{x}}{\Delta t}$$

ACCELERATION TELLS YOU "HOW FAST IS THE VELOCITY CHANGING"? - AND IN WHAT DIRECTION!

UNITS $a = \frac{\Delta v}{\Delta t} = \frac{\text{"SPEED"}}{\text{TIME}} = \frac{\text{"LENGTH/TIME"}}{\text{TIME}} = \frac{\text{LENGTH}}{\text{TIME}\cdot\text{TIME}}$

$\left(\frac{\text{METER/SEC}}{\text{SEC}}\right) = \frac{\text{METER}}{\text{SEC}\cdot\text{SEC}}$ ✓ $\left(\frac{\text{FOOT}}{\text{DAY}\cdot\text{HOUR}}\right)$ ✓ $\left(\frac{\text{MILE}}{\text{SEC}\cdot\text{MIN}}\right)$ ✓ $\frac{\text{MILE}}{\text{HOUR SEC}}$ $\left(= \frac{(\text{MILE/HOUR})}{\text{SEC}}\right)$

~~$\frac{\text{INCH}}{\text{SEC}\cdot\text{METER}}$~~ NOPE.

OUR STANDARD $= \frac{\text{METER/SEC}}{\text{SEC}} = \frac{\text{METER}}{\text{SEC}^2}$

VECTORS IN 2 DIMENSIONS

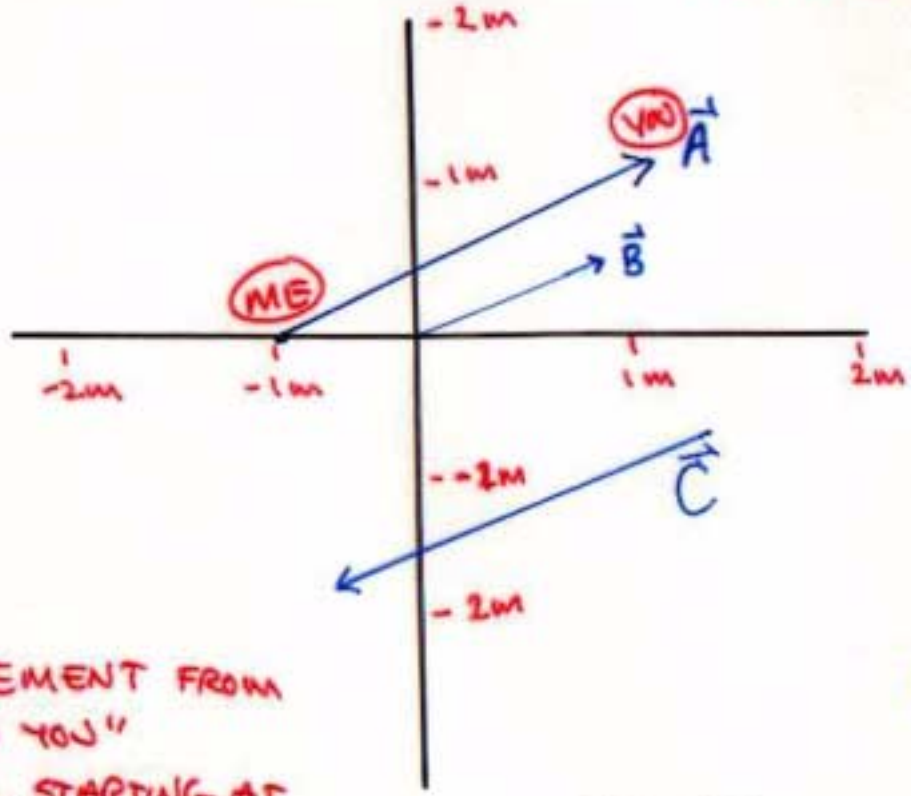
8-F

PROPERTIES OF AN ARROW! LENGTH AND DIRECTION

2 QUANITIES.

GRAPHICAL REPRESENTATION

DISPLACEMENTS



$\vec{A}$ = "DISPLACEMENT FROM ME TO YOU"

AN ARROW, STARTING AT (ME) ENDING AT (YOU)

AND WHOSE LENGTH = DISTANCE BETWEEN US.

$\vec{B} = \vec{A}/2$ ... SAME DIRECTION 1/2 LENGTH!

$\vec{A}$ HAS A DIRECTION, LENGTH

CHANGE THE LENGTH OF $\vec{A}$:

$\vec{B} = \vec{A}/2$

$\vec{B}$ IS IN THE SAME DIRECTION AS $\vec{A}$

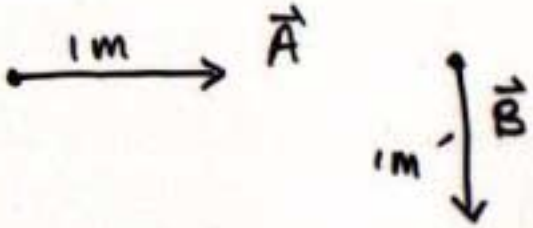
$\vec{C} = -\vec{A}$ EXACTLY OPPOSITE OF $\vec{A}$.

CHANGE LENGTH OF A VECTOR

BY MULTIPLYING IT BY A NUMBER.

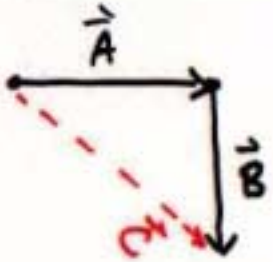
(CAN CHANGE ITS DIRECTION - TO OPPOSITE)

☐ ADD UP VECTORS ... DIFFERENTLY:

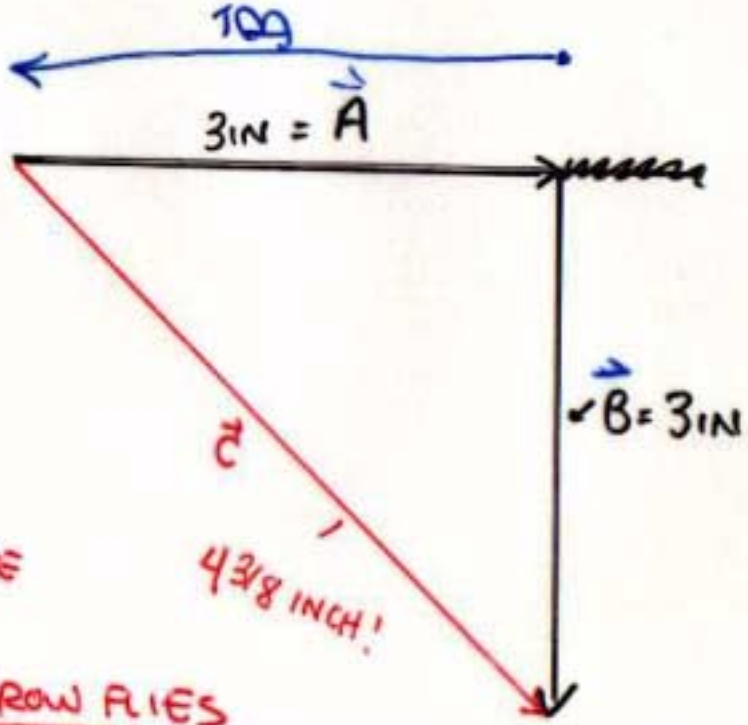


BOTH $\vec{A}$, $\vec{B}$ ARE 1 METER LONG.

PLACE VECTORS - TAIL-TO-HEAD TO ADD THEM!



$\vec{A}+\vec{B}=\vec{C}$ ... WHAT IS THE LENGTH OF C?



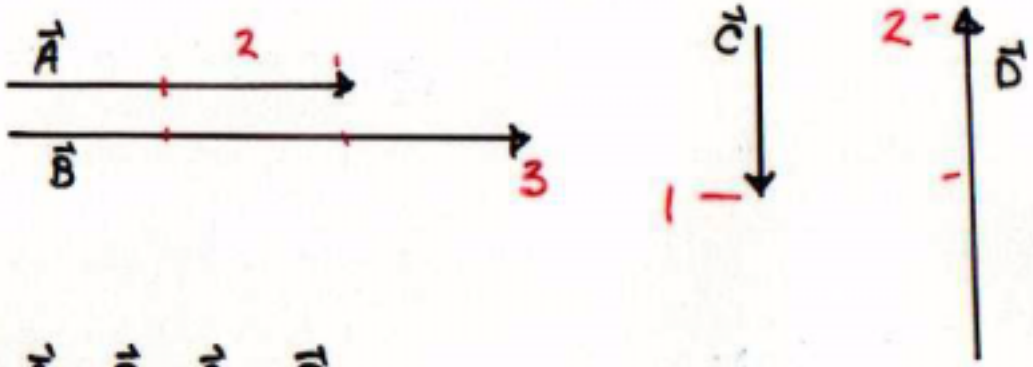
ADD $\vec{A}$ AND $\vec{B}$ AND 1+1≠2?! DIRECTION COUNTS!

3IN + 3IN = 6IN

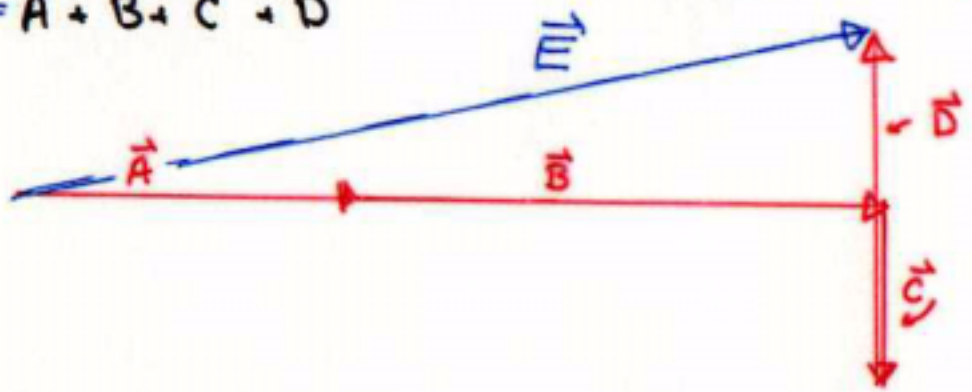
= "HOW FAR YOU WALK ALONG THE PATH"

4 3/8 IN = AS THE CROW FLIES

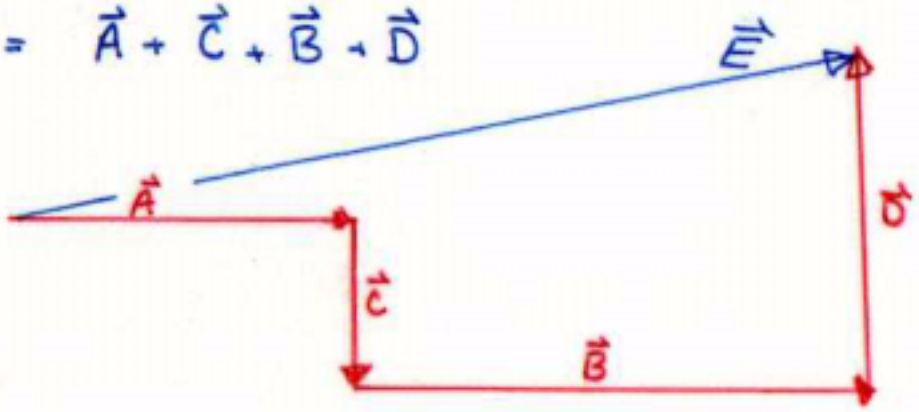
☐ YOU CAN ADD VECTORS IN ANY ORDER YOU WANT.



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



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



"LIKE GIVING DRIVING DIRECTIONS"

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

=

GO EAST 2 MILES.
THEN GO EAST 3 MILES.
THEN GO SOUTH 1 MILE
THEN GO NORTH 2 MILES!

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

GO EAST 2 MILES.
THEN GO SOUTH 1 MILE.
THEN GO EAST 3 MILES.
THEN GO NORTH 2 MILES.

BOTH SETS OF DIRECTIONS GO TO THE SAME PLACE $\vec{E}$.

☐ EXAMPLES.

$\vec{A}$ =

$\vec{A}$ IS "TO THE RIGHT" 2 INCHES LONG

$\vec{A} = (2\text{IN}, 0)$ ← "COORDINATES"

$\vec{B}$ =

$\vec{B}$ IS "TO THE LEFT" 1 INCH LONG.

$\vec{B} = (-1\text{ INCH}, 0)$

$\vec{C}$ =

$\vec{C}$ IS "UP" 2 INCHES LONG

$\vec{C} = (0, 2\text{ INCH})$

$\vec{D}$ =

"2 UP AND 2 TO THE RIGHT"

$\vec{D} = (2\text{ INCH}, 2\text{ INCH})$

DON'T HAVE TO POINT @ STRAIGHT UP OR DOWN!

VECTOR ADDITION:

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

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

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

$\vec{A} - \vec{D} =$