~~4/18/01~~
Lect Sept 12

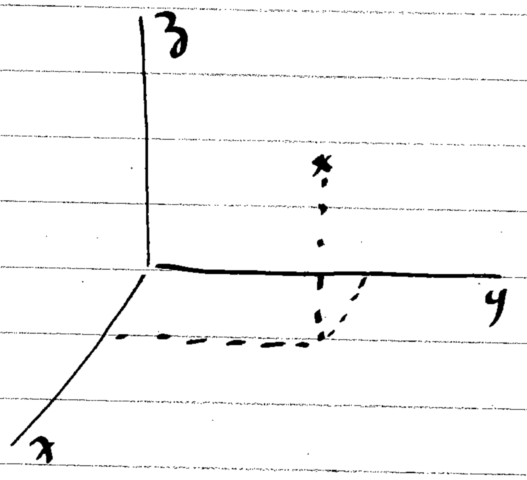
Temperature Scalar ⇐ #

1-d motion

(Sign)(Scalar ← #)

Multidimensional Motion

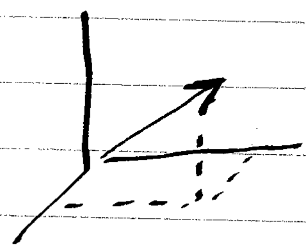
Position



⇒ 3 #'s

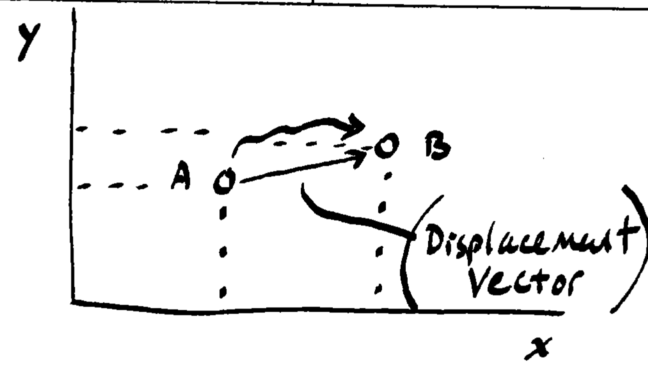
Velocity → Magnitude + direction

Think of an arrow



Again 3 #'s
can specify
a Magnitude
+
~~and~~ a direction

Digress on vectors

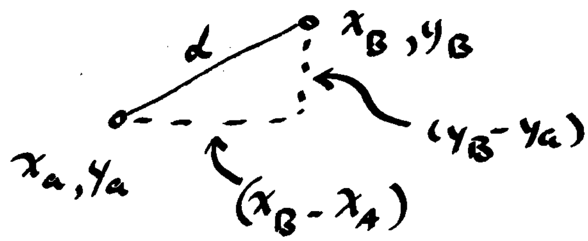


consider ball moving from A to B in the x-y plane

displacement from A to B has both a magnitude and a direction

represent w/ a vector

length of vector = distance from A to B



Pythagorian Theorem

$$d = \sqrt{\underbrace{(x_B - x_A)^2}_{(\Delta x)^2} + \underbrace{(y_B - y_A)^2}_{(\Delta y)^2}}$$

direction ≡ along the line joining A and B
Pointed from A toward B
components of vector $(\Delta x, \Delta y, 0)$

In 3 dimensions – see next page

Vectors – Lesson 1

Vectors : Made up of 3 components or #'s

Have Magnitude and direction

All vectors w/ same direction and Magnitude are equivalent regardless of placement

Picture as an Arrow

$\vec{A} = \nearrow$

$-\vec{A} = \swarrow$ same magnitude, opposite direction

Magnitude of $\vec{A} = |\vec{A}|$

$|a\vec{A}| = |a||\vec{A}|$ in direction of $\vec{A}$

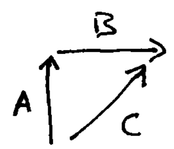
mult vector by constant just scales magnitude

Vector Addition

geometrical

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

$A \uparrow \quad \xrightarrow{B} \quad = \vec{C} \nearrow$



Head to tail Addition

Boat crossing river example

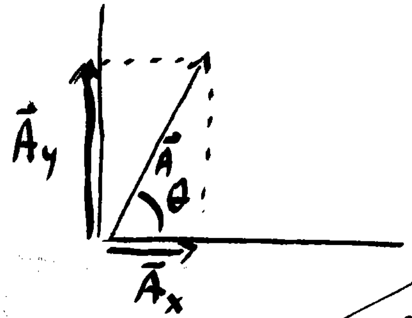
Analytical

Have Student Push you as you walk straight

Addition of vectors : Analytical

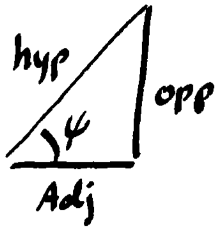
Any vector can be broken up into component

~~Which components you choose depends on the problem~~



$$\frac{|\vec{A}_x|}{|\vec{A}|} = \sin\theta$$

recall



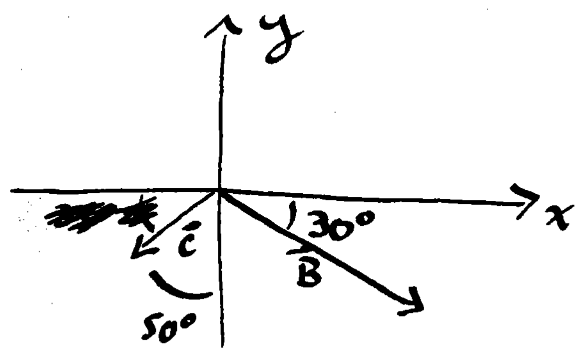
$$\frac{opp}{hyp} = \sin\psi$$

$$\frac{Adj}{hyp} = \cos\psi$$

$$|\vec{A}_x| = |\vec{A}| \sin\theta$$

$$|\vec{A}_y| = |\vec{A}| \cos\theta$$

Example



what is vector sum of $\vec{B}$ and $\vec{C}$

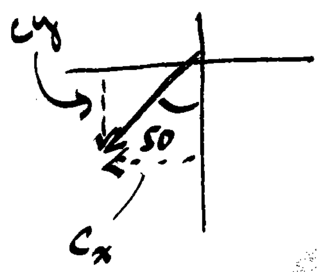
$$\vec{B} + \vec{C} = \vec{R}$$

?

"resolve" $\vec{C}$ into components

$$C_x = -|\vec{C}| \sin 50$$

$$C_y = -|\vec{C}| \cos 50$$



$$B_x = |\vec{B}| \cos 30$$

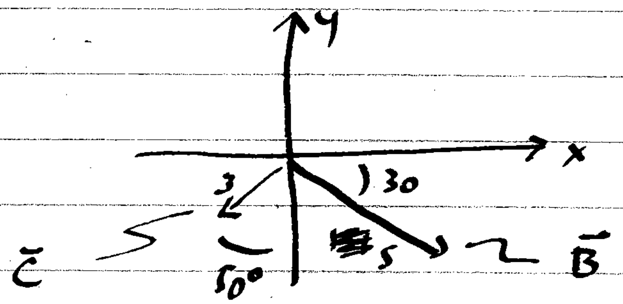
$$B_y = |\vec{B}| \sin 30$$

More on vectors later

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

$\vec{B}$ = vector w/ Magn. 5 30° from +x axis in −y direction

$\vec{C}$ = vector w/ Magn. 3 50° from − y axis in − x direction



resolve $\vec{B}$ into components (create 1d parts from 2d quantity)

$B_x = |\vec{B}| \cos 30$

$B_y = -|\vec{B}| \sin 30$

resolve $\vec{C}$ into components

$C_x = -|\vec{C}| \sin 50$

$C_y = -|\vec{C}| \cos 50$

$R_x = \Sigma$ of x components of vectors in sum

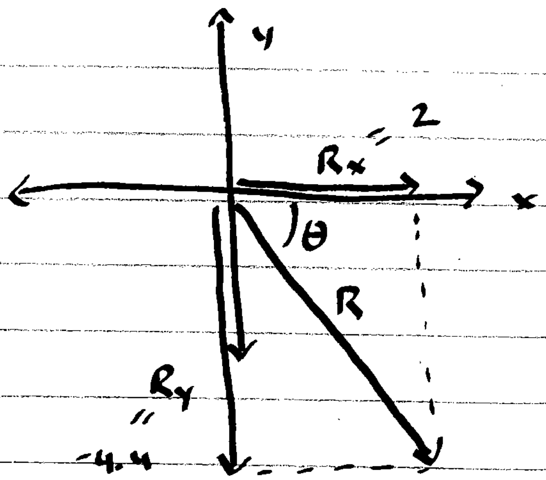
$R_x = |\vec{B}| \cos 30 - |\vec{C}| \sin 50$

$R_x = 5 \cos 30 - 3 \sin 50 = 2$

$R_y = \Sigma$ of y component of vectors in sum

$R_y = -|\vec{B}| \sin 30 - |\vec{C}| \cos 50$

$= -5 \sin 30 - 3 \cos 50 = -4.4$



$|\vec{R}|^2 = R_x^2 + R_y^2 = 23.4$ $\quad |\vec{R}| = 4.8$

$\tan\theta = \frac{|R_y|}{|R_x|} = \frac{4.4}{2} \Rightarrow \theta = 65.6^\circ$

down from +x axis
in -y direction

or clockwise from x-axis

Suppose you want to use a vector to define a direction only

Can do this by dividing out the magnitude to create a "unit vector"

The unit vector in the $\vec{r}$ direction is

$$\frac{\vec{r}}{|\vec{r}|} \equiv \hat{r} \qquad |\hat{r}| = 1$$

note that $|\vec{r}|$ is not necessarily 1