# Announcements

## ① Stand-alone WebAssign cards

* still not in — but have until Sept. 6
* your scores will not be lost!
* grace period will be extended if necessary
* please leave your name with me

## ② Turning to the DARK SIDE ...

* after PHY 2048-49 ⇒ PHY 3101 (Mod. Phys.)
* physics minor ⇒ PHY 3101 & two 3-4000 levels
* physics major ⇒ consider PHY 2060-61

Prof. Selman Hirshfield
NPB 2138 (392-9387)
selman@phys.ufl.edu

## ③ Prof. Hill takes over Friday

* I'm back Oct 1
* can still see me for help

## ④ Exam # 1, Mon., Sept. 13, 8:20-10:20 pm

A-F ⇒ FLI 50
G-O ⇒ CSE A101
P-Z ⇒ FAB 103/105

* Chapters 1-4 (easy ⇒ don't miss it!)
* one calculator, 1 $8\frac{1}{2} \times 11''$ formula sheet

# Vectors vs. Scalars



① Scalars have only magnitude

* Eg distance and speed

② Vectors have magnitude and direction

* Eg displacement, velocity and acceleration

## Representing Vectors

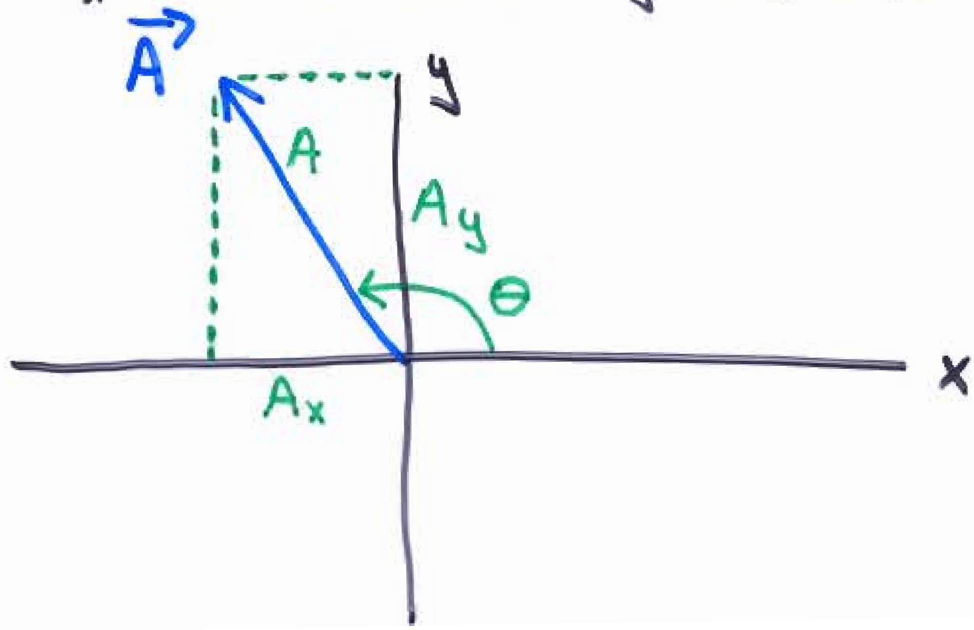
Eg $\vec{A}$

① Magnitude and direction

* Eg $A = 50$ and $\theta = 128°$

② Components

* Eg $A_x \cong -30.78$ and $A_y \cong +39.40$



# Converting

① A and $\theta$ $\Rightarrow$ $A_x = A\cos\theta$ and $A_y = A\sin\theta$

② $A_x$ and $A_y$ $\Rightarrow$ $A = \sqrt{A_x^2 + A_y^2}$

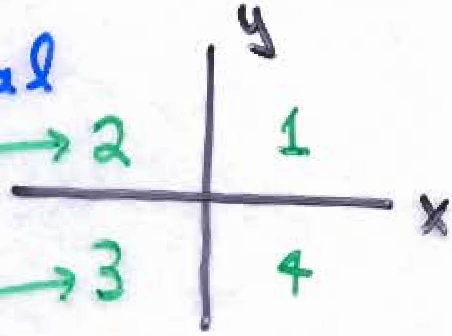
$$\theta = \tan^{-1}\left(\frac{A_y}{A_x}\right) \pm 180^\circ$$

## Subtleties

① Quadrants 2 and 3 are special

$\theta = \tan^{-1}\left(\frac{A_y}{A_x}\right) + 180^\circ \longrightarrow 2$

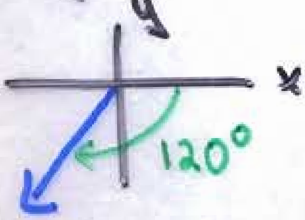
$\theta = \tan^{-1}\left(\frac{A_y}{A_x}\right) - 180^\circ \longrightarrow 3$




② Can (and WILL) give "direction" w.r.t. different axes

* Eg "30° W of N"


* Eg "120° clockwise of +x"




③ NB distinction between degrees and radians

Know what your calculator is doing!

9/1/04
PHY2048

# Vector Arithmetic

## ① Multiplication by numbers

* $(\alpha\vec{A})_x = \alpha A_x$ and $(\alpha\vec{A})_y = \alpha A_y$
* magnitude $= \alpha A$, direction $= \theta$ (no change)

## ② Addition of vectors

* $(\vec{A}+\vec{B})_x = A_x + B_x$ and $(\vec{A}+\vec{B})_y = A_y + B_y$
* mag. & dir. not simple!

## ③ Familiar rules of arithmetic

* $\vec{A}+\vec{B} = \vec{B}+\vec{A}$
* $(\vec{A}+\vec{B})+\vec{C} = \vec{A}+(\vec{B}+\vec{C})$
* $\alpha(\vec{A}+\vec{B}) = \alpha\vec{A}+\alpha\vec{B}$

## Application to Kinematics

* velocity $\vec{v}(t) = \vec{v}_0 + \int_0^t dt'\,\vec{a}(t')$
* position $\vec{q}(t) = \vec{q}_0 + \vec{v}_0 t + \int_0^t dt' \int_0^{t'} dt''\,\vec{a}(t'')$

$$\vec{a}(t) = \vec{a}_0 \Rightarrow \left\{ \begin{array}{l} \vec{v}(t) = \vec{v}_0 + \vec{a}_0 t \\ \vec{q}(t) = \vec{q}_0 + \vec{v}_0 t + \frac{1}{2}\vec{a}_0 t^2 \end{array} \right\}$$

# Unit Vectors (in D=3)



* $\hat{\imath}$ has magnitude 1, directed along + x axis
* $\hat{\jmath}$ " " + y axis
* $\hat{k}$ " " + z axis


$$\vec{A} = A_x \hat{\imath} + A_y \hat{\jmath} + A_z \hat{k}$$

## Multiplying Vectors

① Scalar Product $\equiv \vec{A} \cdot \vec{B}$

* $\vec{A} \cdot \vec{B} = A_x B_x + A_y B_y + A_z B_z$
* $\vec{A} \cdot \vec{B} = A\ B \cos(\angle AB)$
* NB $A = \sqrt{\vec{A} \cdot \vec{A}}$ & $\vec{A} \cdot \vec{B} = \vec{B} \cdot \vec{A}$

② Vector Product $\equiv \vec{A} \times \vec{B}$

* $\vec{A} \times \vec{B} = (A_y B_z - A_z B_y)\hat{\imath} + (A_z B_x - A_x B_z)\hat{\jmath} + (A_x B_y - A_y B_x)\hat{k}$
* mag $= A B \,|\sin(\angle AB)|$
* direction $= \perp \vec{A}$ & $\vec{B}$ (right hand rule)
* NB $\vec{A} \times \vec{B} = -\vec{B} \times \vec{A}$
* $\hat{\imath} \times \hat{\jmath} = \hat{k}$
  $\hat{\jmath} \times \hat{k} = \hat{\imath}$
  $\hat{k} \times \hat{\imath} = \hat{\jmath}$

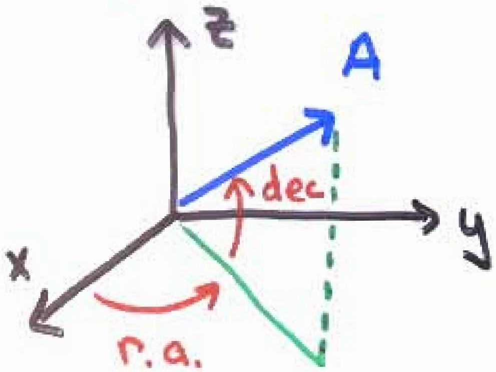
# Using Scalar Products

① Distance from $\vec{A}$ to $\vec{B}$ $= \sqrt{(\vec{A}-\vec{B})\cdot(\vec{A}-\vec{B})}$

② Angle between $\vec{A}$ and $\vec{B}$ $= \cos^{-1}\left(\dfrac{\vec{A}\cdot\vec{B}}{AB}\right)$

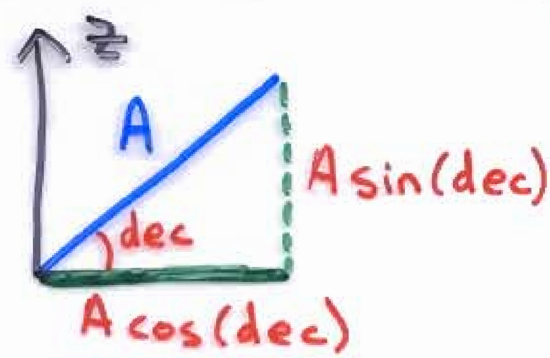
## Eg Stars!

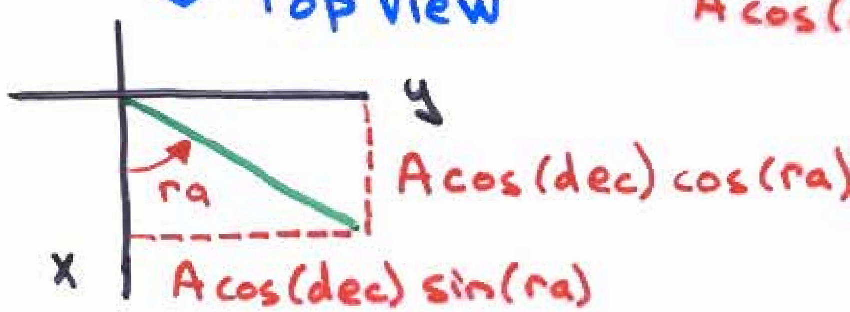
| Star | Distance | Declination | Right Ascension |
|---|---|---|---|
| Aldebaran | 68.0 ly | 16° 30′ | 4h 35.5 min |
| Altair | 16.5 ly | 8° 51′ | 19h 50.5 min |




$\Rightarrow$ Side View

$\Downarrow$ Top View




| | Aldebaran | Altair |
|---|---|---|
| $x = A\cos(\text{dec})\cos(\text{ra})$ | 23.5 | 7.6 |
| $y = A\cos(\text{dec})\sin(\text{ra})$ | 60.8 | −14.4 |
| $z = A\sin(\text{dec})$ | 19.3 | 2.5 |

* distance ≅ 78.7 ly

* angle ≅ 125°