WELCOME
TO

PHYSICS 201

Dr. Luis Dias

Summer 2007

M, Tu, Wed, Th 10am-12pm

245 Walter Hall

PHYSICS 201 - Summer 2007

- TEXTBOOK: Cutnell & Johnson, 6th ed.
- SYLLABUS : Please READ IT carefully.
- **LONCAPA**
  - **Learning Online Network with a Computer Assisted Personalized Approach**
    - Means everyone's homework problems are *slightly* different
    - Include values (and units) in all homework problems.
  - **All Homework and Reading Quizzes will be completed online**
- PRS – Personal Response System
  - **Participation grade and attendance.**
  - **We'll use the system every class - come early and pick your remote.**

First PRS: Have you had Physics before?

1. High School Advanced Physics
2. High School Regular Physics
3. Physics 201
4. Physics 251
5. Have not had Physics before
6. None of the above

KEY info

- Course website: http://loncapa.phy.ohiou.edu
  - **Reading quizzes (timed!), Feedback, Homework**
  - **Lab manual document downloads**
  - **Past exams (practice), extra materials, announcements**

- Help sessions: Mon, Tu, W, Th - 1-5pm
  - **Location: Clippinger 036 (next to the lab)**
  - **Starts *tomorrow* (6/19)**
- Lab sessions: start on Wednesday and Thursday (06/20 and 06/21)

Reminders

- **Reading quiz #1 due Wed 6/20 before class.**
  - I **strongly** suggest you do it by tomorrow morning!
- **Reading quiz #2 also due Wed 6/20 before class.**

- **HW#1 due Wednesday 6/20 at 11:59pm.**
- **HW#2 due Sunday 6/24 at 11:59pm.**

- **Math Quiz: Test your algebra/trigonometry skills**
  - Due Sunday 06/24 (40min to do it!) BUT use it as practice for HW #1 and #2…

- **Lab sessions: start this coming Wed/Thu**
  - Download lab manual from LONCAPA site

- **EXAM 1: Next Thursday (06/29).**
  - Topics: Chapters 1 and 2

Phys 201: what is it about?

- Phys 200 series: Introduction to Physics.

- Phys 201: study of *Classical Mechanics*, one of the many branches of Physics.
  - ***Electromagnetism*, *Thermodynamics* and *Quantum Mechanics* are also important branches of Physics.**

- Phys 201 is also part of your College experience:
  - **"Learn how to learn": Acquire new knowledge, develop problem-solving skills and learn new concepts in a relatively short amount of time.**

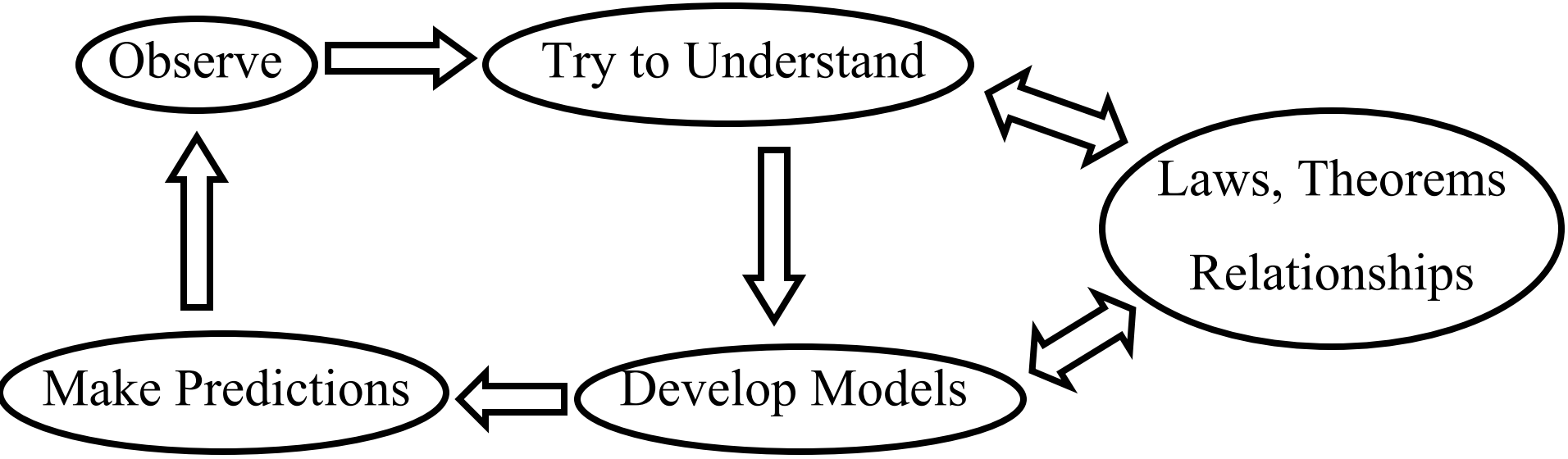
Course Outline

- Review and Intro (chapter 1)
- Kinematics in 1D and 2D (chapters 2 and 3)
- Newton's Laws (chapter 4)
- Circular motion (chapter 5)
- Torque (chapter 9)
- Conservation of Energy and momentum (chapters 6 and 7)
- Rotational Kinematics and Dynamics (ch. 8)

Physics is a *natural Science*. Scientists try to comprehend natural phenomena in a systematic way.

How? Scientific method: Interplay between theory and experiment.

Science builds itself on empirical evidence and theoretical models.



Standards and Units

- Measurements: numerical values and **UNITS**!!!
  - **Need Standards - Reproduce measurements accurately**
  - **Ex: the *Standard kilogram***

- We'll use the **SI** - International System of Units:

	SI	CGS
Length	**meter** (m)	centimeter (cm)
Time	**second** (s)	second (s)
Mass	**kilogram** (kg)	grams (g)

  - **English System - Foot, Second, Pound**

Unit Conversions SI-English

- Useful conversion factors:
  - **1 in = 2.54 cm**
  - **1 m = 3.28 ft**
  - **1 mile = 1.609 km**
  - **1 m/s = 3.6 km/h [1 km/h = 1000 m/3600 s = (1 / 3.6) m/s]**
  - **1 kg = 2.2 lb**

Unit Conversion

- Can't mix units when adding or subtracting - Need to convert.
  - **Ex: 1 mile + 1 km = 1.61 km + 1 km =2.61 km**

- Can always multiply by "1".
  - **Ex:** $1.61\text{ km}=1\text{ mile} \Rightarrow 1=\frac{1.61\text{ km}}{1\text{ mile}}=\frac{1\text{ mile}}{1.61\text{ km}}$
- Can cancel units algebraically.
  - **Ex:**

$$80\text{ km/h}=80\times 1\text{ km/h}=80\times\frac{1\text{ mile}}{1.61\cancel{\text{km}}}\ \frac{\cancel{\text{km}}}{\text{h}}=\frac{80}{1.61}\text{mile/h}=49.68\text{mile/h}$$

Example:

You throw a baseball and it is 'clocked' at 30m/s by a radar gun.

- **Is this a reasonable number?**
- **Convert to mi/hr (mph).**

67mph (A little bit more than two times the value in m/s.)

- Scientific Notation: Powers of Ten
  - **$15974.6 = 1.59746 \times 10^{4}$**
  - **$0.000084764 = 8.4764 \times 10^{-5}$**
- Prefixes: Learn these:
  - **giga (G): 10^{9}**
  - **mega (M): 10^{6}**
  - **kilo (k): 10^{3}**
  - **centi (c): 10^{-2}**
  - **mili (m): 10^{-3}**
  - **micro (μ): 10^{-6}**
  - **nano (n): 10^{-9}**
  - **Table inside cover of text**

powers of ten

Significant Figures

- Ignore leading zeros
- Ignore trailing zeros if no decimal point
- Safest way: scientific notation
- Homework: 3-5 typically accepted

A bucket has a volume of 1560 cm^3. What is it's volume in m^3?

(1) 1.56×10^{-6} m^3 (2) 1.56×10^{-4} m^3 (3) 1.56×10^{-3} m^3
(4) 1.56×10^{-2} m^3 (5) 1.56×10^{-1} m^3 (6) 1.56 m^3
(7) 1.56×10^{2} m^3 (8) 1.56×10^{3} m^3 (9) 1.56×10^{6} m^3
(0) 1.56×10^{9} m^3

$1560 cm^3$ (1m/100cm)*(1m/100cm)*(1m/100cm)

Dimensional Analysis

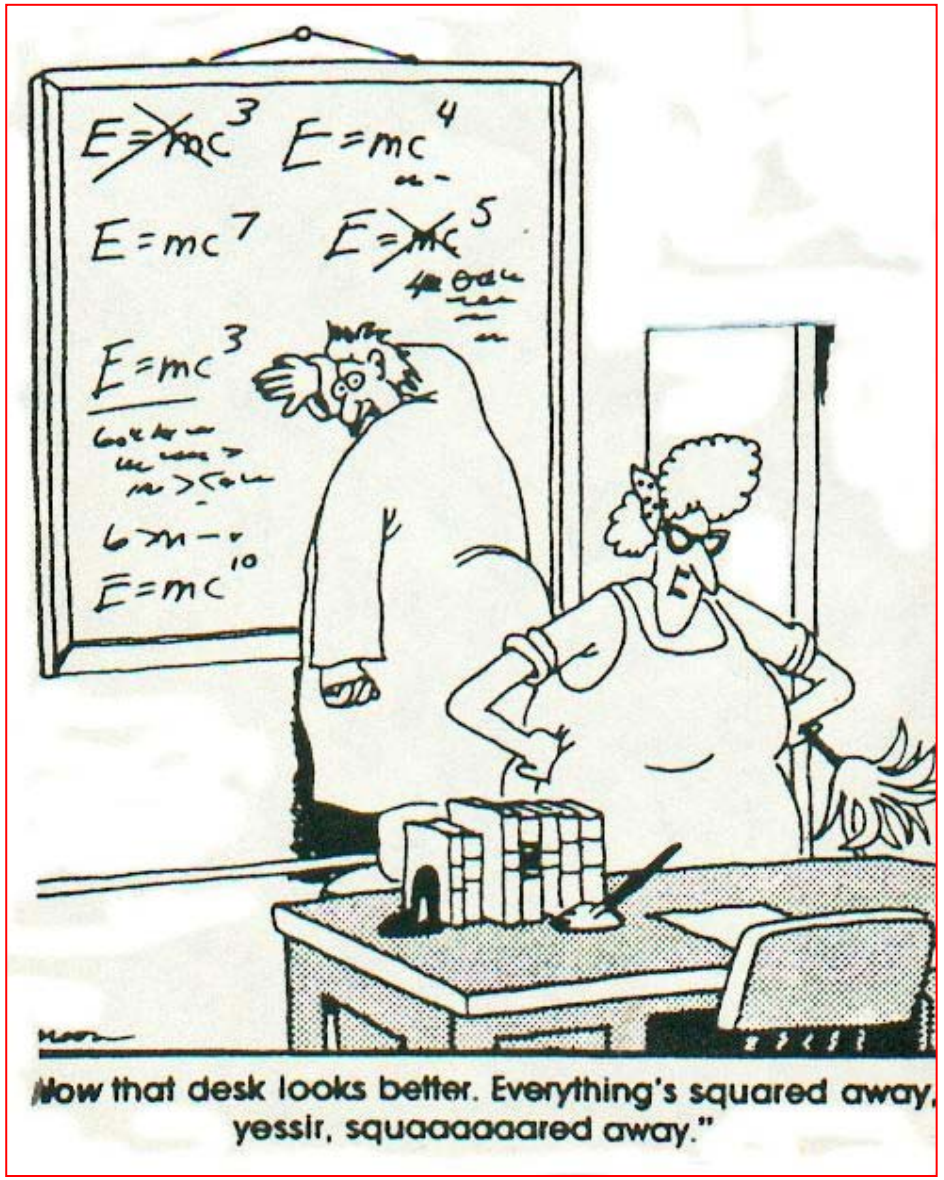
- Dimension - physical nature of quantity (length, mass, time)
  - **Can be derived dimensions or units: acceleration is length/time^2**
- All terms in an equation must have same dimensions! Otherwise it can't be right.
- Can use algebra to figure out dimensions and units
  - **Force = (mass) x (acceleration)**
  - **[Force] = mass x (length/time^2)**
  - **SI Units of Force: kg m/s^2 (or Newtons - N)**

Dimensional Analysis

- Some possible equations:
  - **$E = mc^2$?**
  - ~~**$E = mc^3$?**~~
  - ~~**$E = mc^7$?**~~
- Units of Energy are:

  kg m^2/s^2

  Check the Units!!



Ratios

- We need to understand the concept of 'scaling'
  - **Example:** **Acceleration = Force / Mass**

Push a block of mass m_1 with force F_1 yields acceleration a_1

If we **double** the force $\rightarrow$ yields acceleration $2a_1$ (double!)

If we **double** the mass $\rightarrow$ yields acceleration $a_1/2$ (half!)

- I now quadruple the force and double the mass. How does the new acceleration compare with a_1?

$m_2=2m_1$; $F_2 = 4F_1$ $a_2 = F_2/m_2 = (4F_1)/(2m_1) = 2a_1$

Or can write as fraction a_2/a_1

You are examining two circles.
Circle 2 has a radius 1.7 times bigger than circle 1.
What is the ratio of the areas?
Express this as the value of the fraction A_2/A_1.

(1) 1/1.7 (2) 1.7 (3) $(1/1.7)^2$ (4) 1.7^2

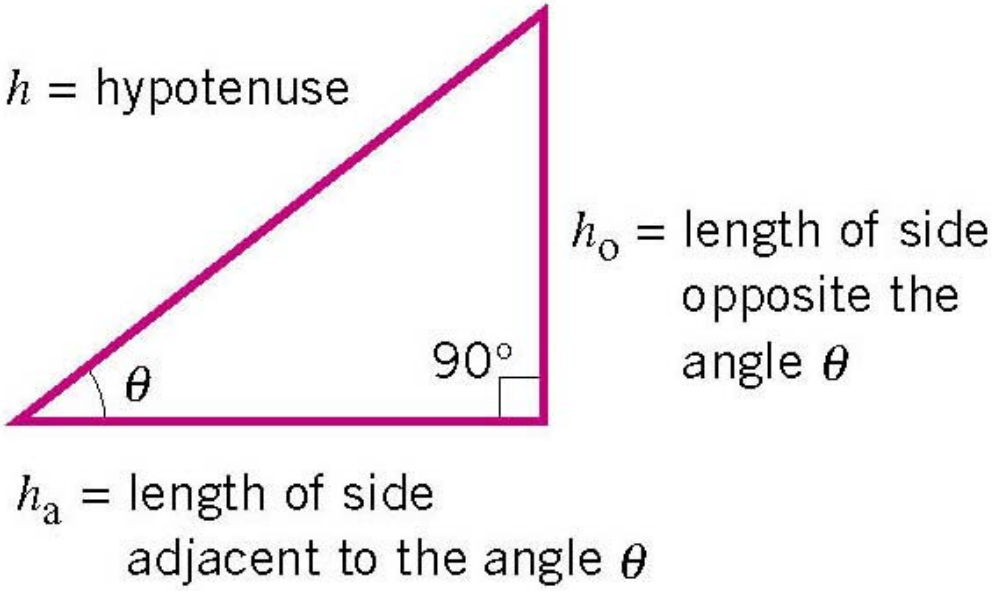
(5) $\sqrt{1/1.7}$ (6) $\sqrt{1.7}$

$$\frac{A_2}{A_1} = \frac{\pi r_2^2}{\pi r_1^2} = \frac{\pi (1.7 r_1)^2}{\pi r_1^2} = (1.7)^2$$

Trigonometry

Pythagoras' Theorem

$$h = \sqrt{h_a^2 + h_o^2}$$



Trigonometric Functions

$$\sin\theta = \frac{\text{opposite}}{\text{hypotenuse}}$$

$$\cos\theta = \frac{\text{adjacent}}{\text{hypotenuse}}$$

$$\tan\theta = \frac{\text{opposite}}{\text{adjacent}}$$

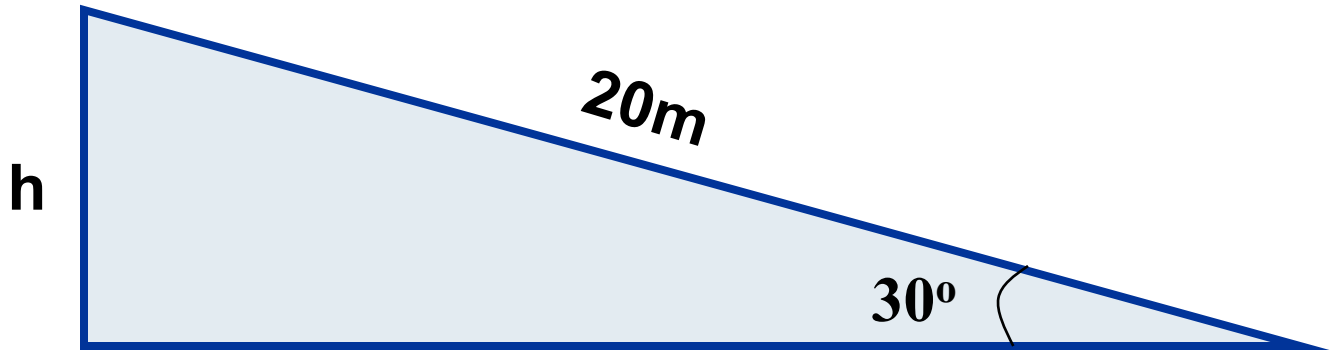
$$\theta = \tan^{-1}\frac{\text{opposite}}{\text{adjacent}}$$

Example:

You walk 20m up to the top of a hill at an incline of 30°.

What is the height of the hill?

Note: DRAW PICTURE!



$\sin(30^o) = h/20m; \quad h = 20m * \sin(30^o) = 10\ m$

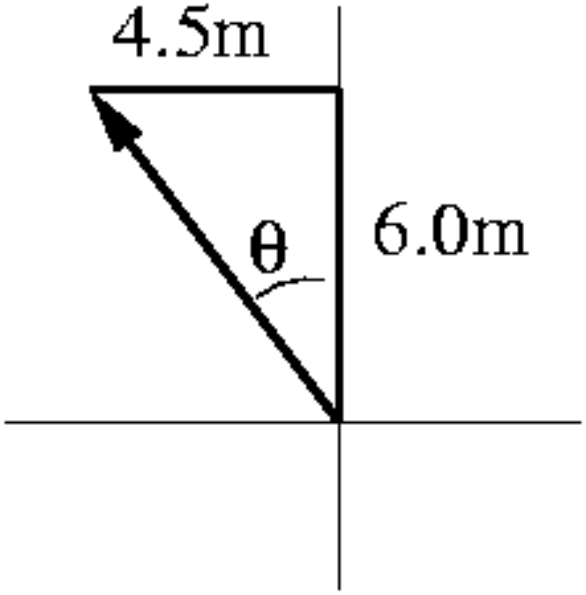
What is the angle θ?

(1) 37°

(2) 41°

(3) 49°

(4) 53



$$\tan^{-1}\left(\frac{4.5m}{6.0m}\right) = 36.9°$$

Reminders

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- **Math Quiz: Test your algebra/trigonometry skills**
  - Due Sunday 06/24 (40min to do it!) BUT
    use it as practice for HW #1 and #2…

- **Lab sessions: start tomorrow &Thursday.**
- **PRINT OUT Lab Report before going to labs**
  - Download lab report from LONCAPA website
  - Fill out the Pre-lab questions BEFORE going to lab!
- **CAPA sessions start *today*: Clippinger 036, M-Th, 1-5pm**

- **EXAM 1: Next Thursday (06/29).**
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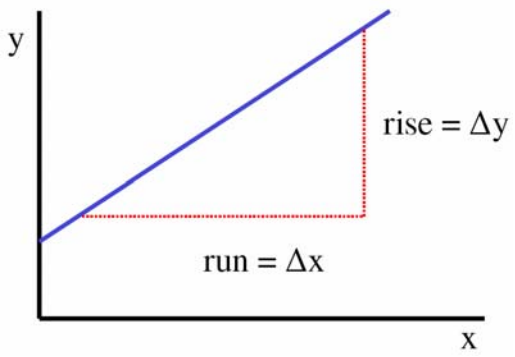
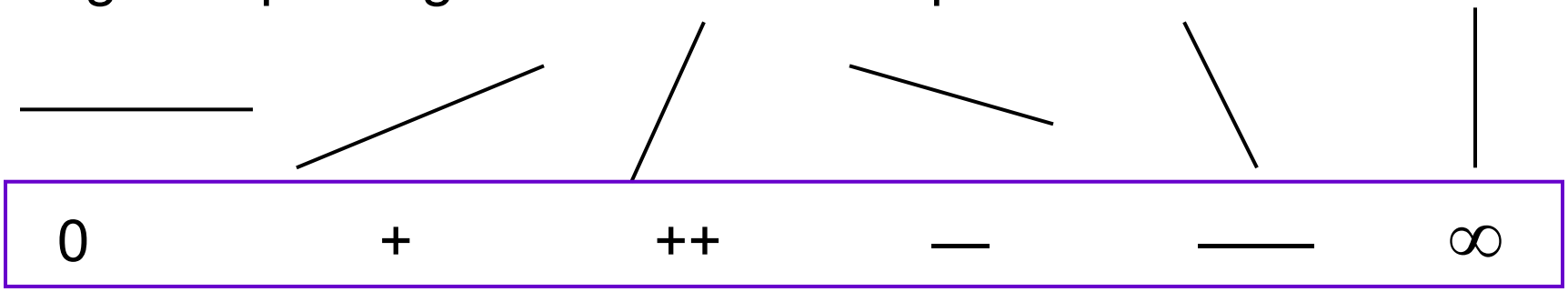
SLOPE



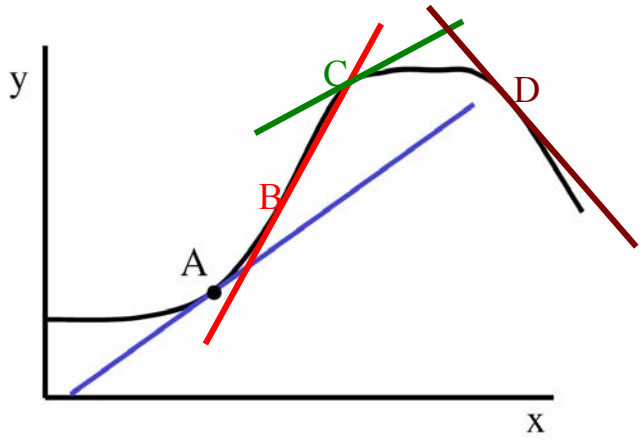
Slope = rise / run = $\frac{\Delta y}{\Delta x}$

Sign of slope determines direction positive / & negative \

Larger slope magnitude means steeper line



Curves change slope (if not straight lines)!!



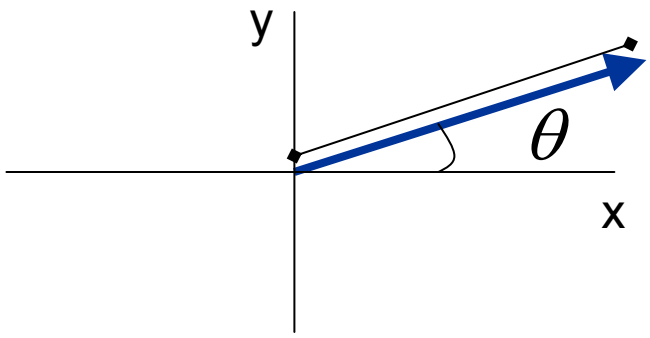
PRS Vector Poll: How are your vector skills?

1. I am quite familiar with vectors and I can handle vector addition/subtraction well.
2. I remember vectors from a previous course. With some practice, I could handle addition/subtraction.
3. I have studied vectors sometime but I'm not sure how two add two vectors anymore.
4. Vectors? Sounds familiar.
5. I have no idea what you're talking about.

Vectors

- ***Scalars*** can be described with a single number. Add arithmetically.
  - **Ex: mass, time, volume, temperature, pressure, ...**

- ***Vectors*** cannot be described by a single number. We need both magnitude AND direction to define a vector.
  - **Ex: displacement, velocity, acceleration, forces, electric and magnetic fields, ...**



$\vec{\mathbf{v}}$ $\quad |\vec{\mathbf{v}}| \rightarrow$ magnitude (length)

$\theta \rightarrow$ direction

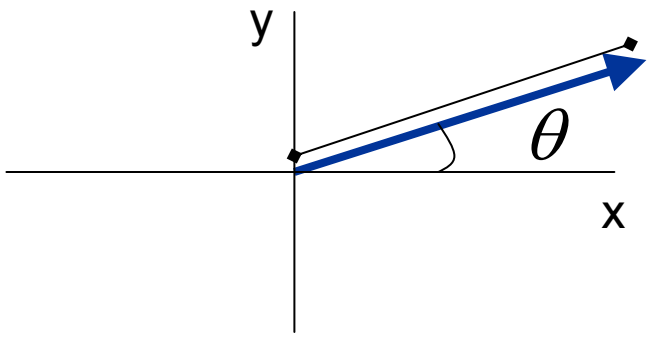
  - **In general, we need need trigonometry to add vectors.**
  - **(Vectors only add arithmetically if they are parallel.)**

Vectors

- ***Scalars*** can be described with a single number. Add arithmetically.
  - **Ex: mass, tim**

Displacement: a vector that points from an object's *initial* position to its *final* position.

- ***Vectors*** cannot be d[illegible]ed by a single number. We need both magnitude AND direction to define a vector.
  - **Ex: displacement, velocity, acceleration, forces, electric and magnetic fields, ...**



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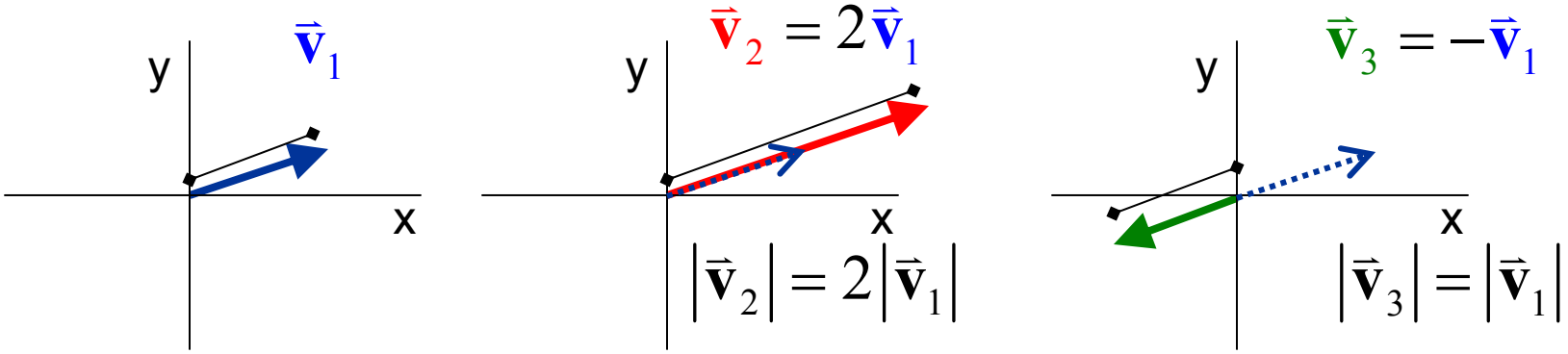
  - **In general, we need need trigonometry to add vectors.**
  - **(Vectors only add arithmetically if they are parallel.)**

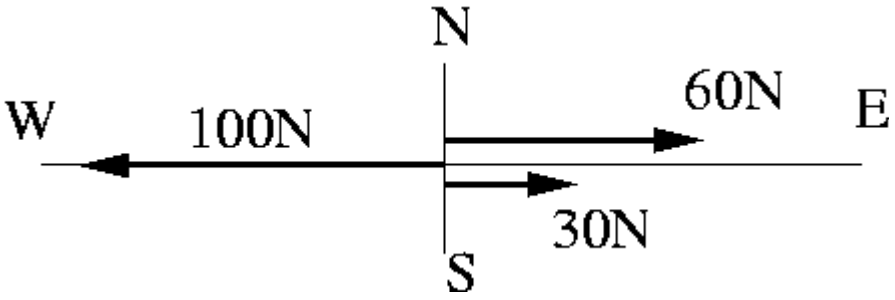
Vector Operations

- Addition: (vector 1) + (vector 2) = (vector 3)
  - **Ex: (java applet)**
- Multiplication by a scalar: (scalar) * (vector 1) = (vector 2)
  - **(-1)*(vector) = vector in opposite direction**
  - **remember: magnitude never negative**



- Subtraction: (vector 1)-(vector 2) = (vector 1) + (-vector 2)
- Java applet:
  - http://www3.interscience.wiley.com:8100/legacy/college/cutnell/0471151831/concepts/index.htm

Three people are pulling on a rope. Rob pulls *East* with a force of 30N (Newtons). Liz pulls *East* with a force of 60N and Sarah pulls *West* with a force of 100N. What is the NET FORCE on the rope?



(1) 10N East
(2) 10N West
(3) 40N East
(4) 40N West
(5) 70N East
(6) 70N West
(7) 190N East
(8) 190N West

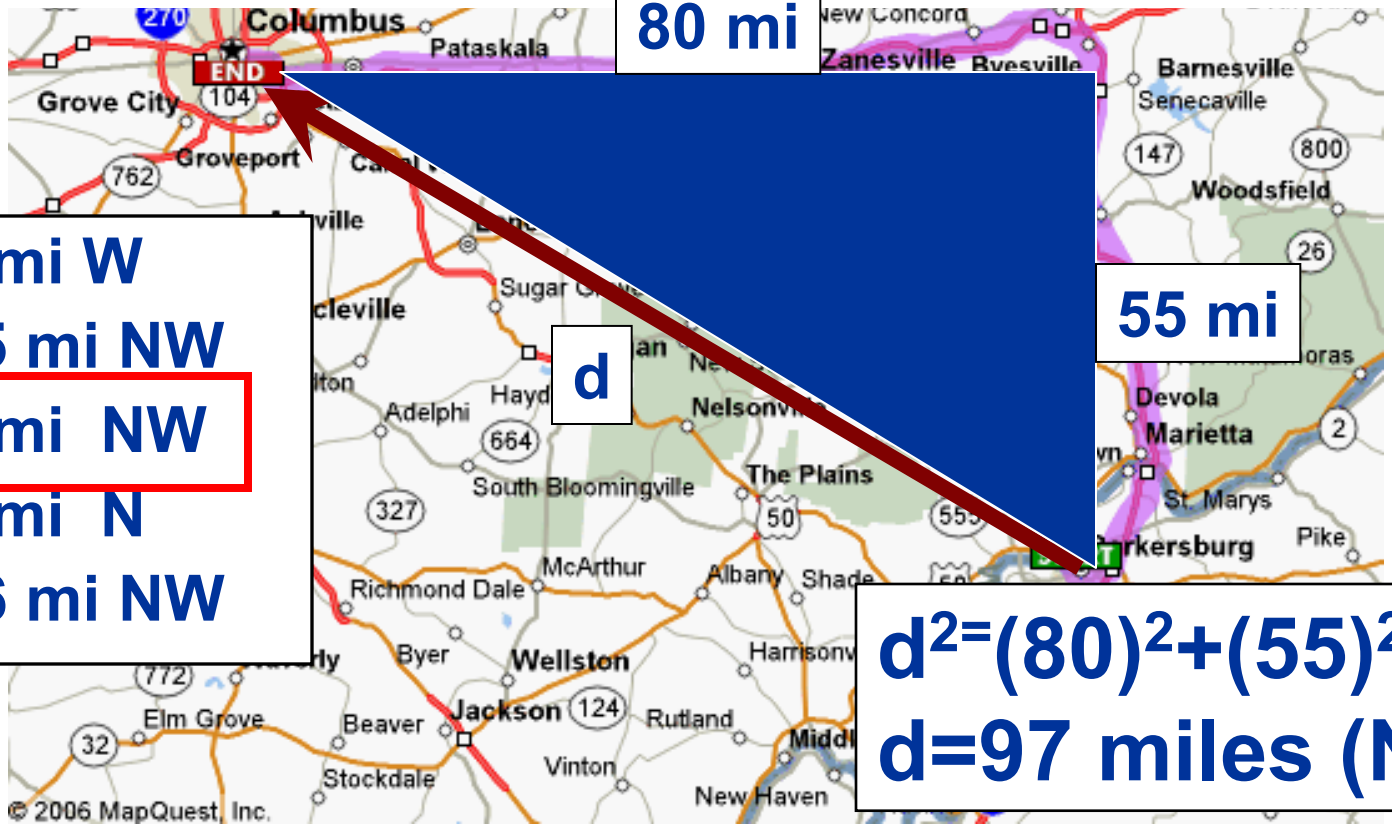
Example:

You drive 55 miles north on 

from Parkersburg.

Then you take 

and drive 80 miles west towards Columbus. What is your total **displacement**?

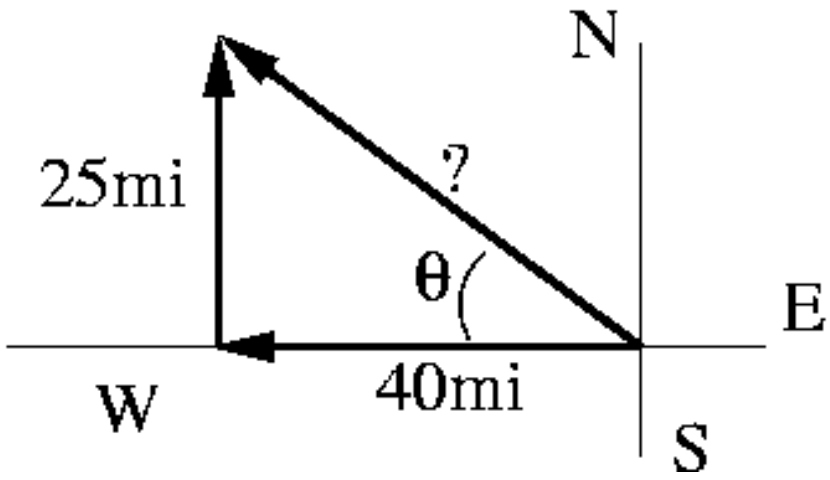


(1) 80 mi W
(2) 135 mi NW
(3) 97 mi NW
(4) 55 mi N
(5) 116 mi NW

$d^2=(80)^2+(55)^2$

$d=97$ miles (NW)

You drive 40 mi due west, then switch drivers.
Your friend then drives 25mi due NORTH.
What is your total displacement?



(1) 47mi 32° N of W

(2) 47mi 39° N of W

(3) 47mi 58° N of W

(4) 65mi 32° N of W

(5) 65mi 39° N of W

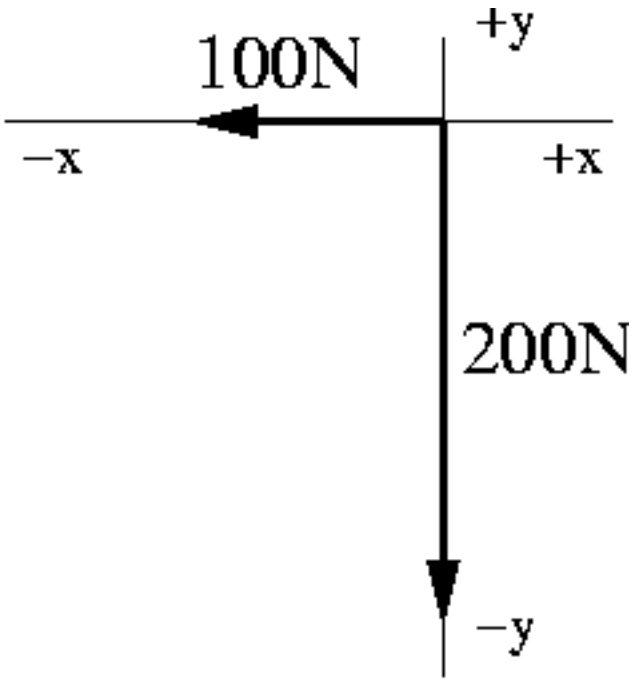
(6) 65mi 58° N of W

$$\text{hyp} = \sqrt{(25mi)^2 + (40mi)^2}$$

$$\tan^{-1}\left(\frac{25mi}{40mi}\right)$$

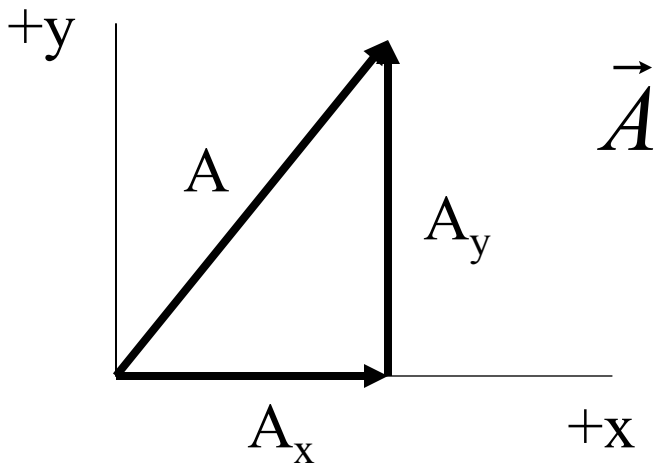
Two forces are acting on an object. What is the net force?

(1) 300N 26° S of W
(2) 300N 60° S of W
(3) 300N 63° S of W
(4) 224N 26° S of W
(5) 224N 60° S of W
(6) 224N 63° S of W

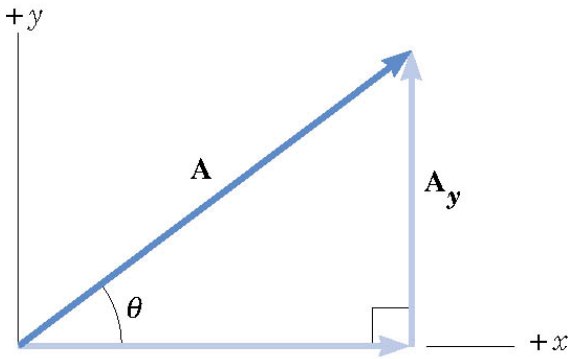


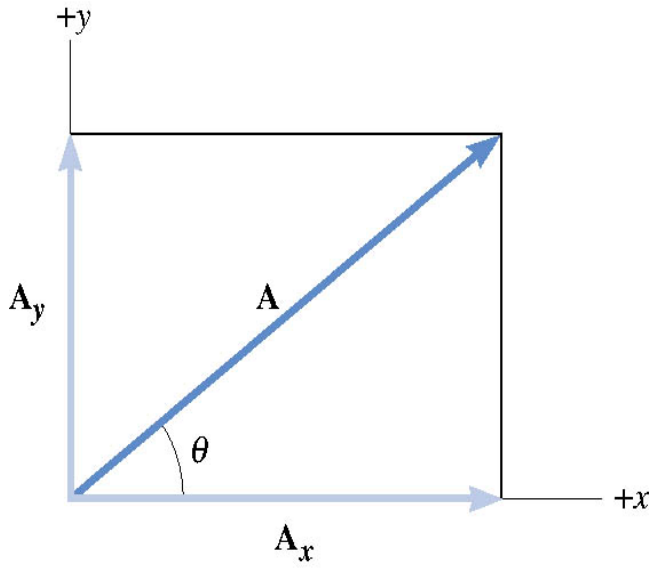
Components

- Can either talk about vector components: $\mathbf{A}_x$= 8m in –x direction
- or treat as scalar (since know which axis): A_x = -8m
- Note: COMPONENTS ALWAYS PARALLEL TO AXES



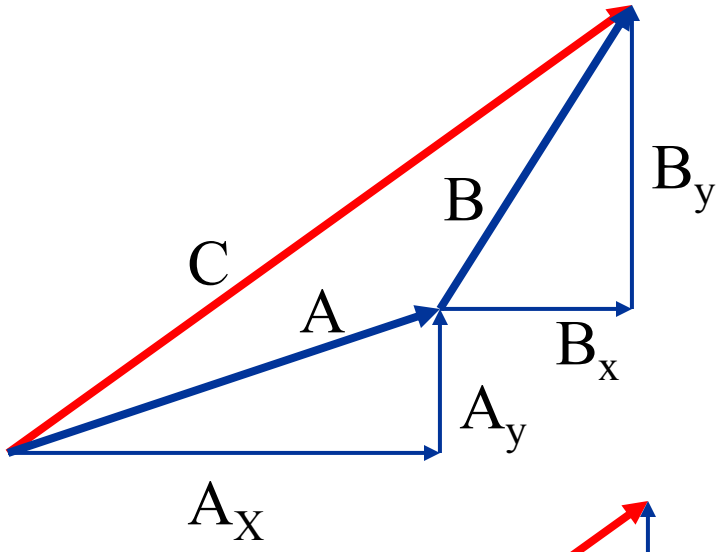
$$\vec{A} = \vec{A}_x + \vec{A}_y$$





Adding Vectors

- Easier to add vectors that are parallel: *Break into components!*

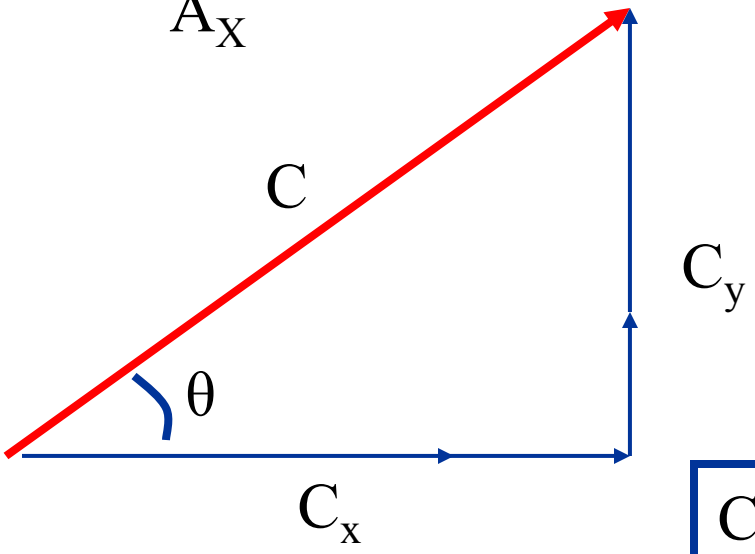


$$\vec{C} = \vec{A} + \vec{B}$$

$$\vec{C} = (\vec{A}_x + \vec{A}_y) + (\vec{B}_x + \vec{B}_y)$$

$$\vec{C} = (\vec{A}_x + \vec{B}_x) + (\vec{A}_y + \vec{B}_y)$$

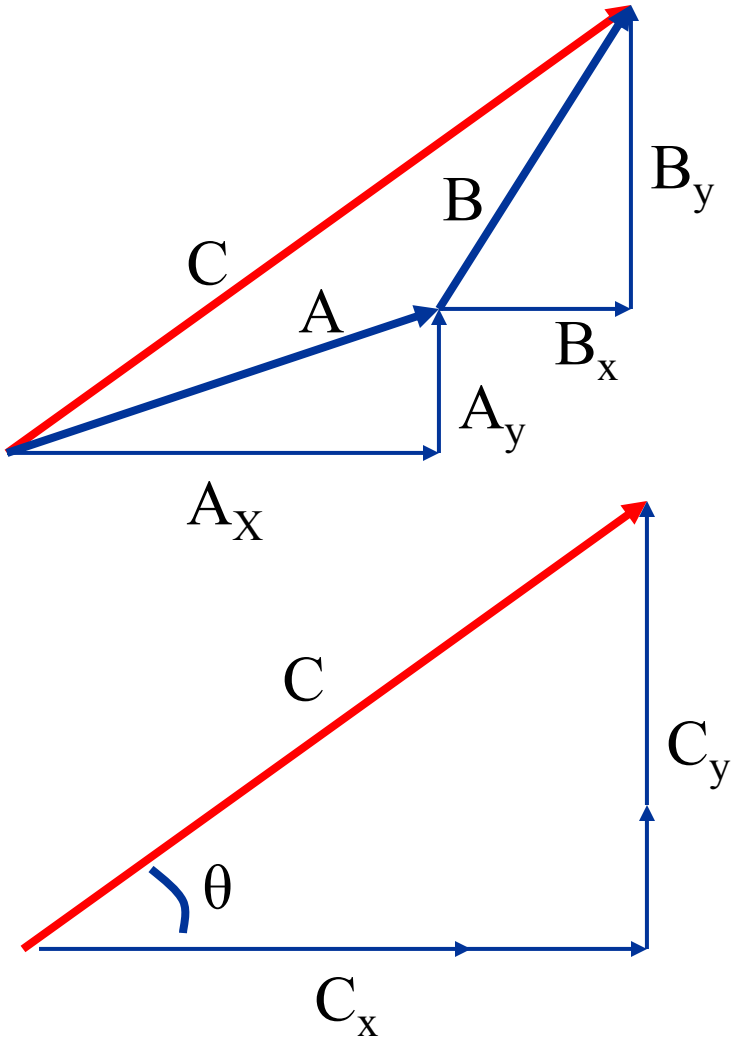
$$\vec{C}_x = \vec{A}_x + \vec{B}_x \qquad \vec{C}_y = \vec{A}_y + \vec{B}_y$$



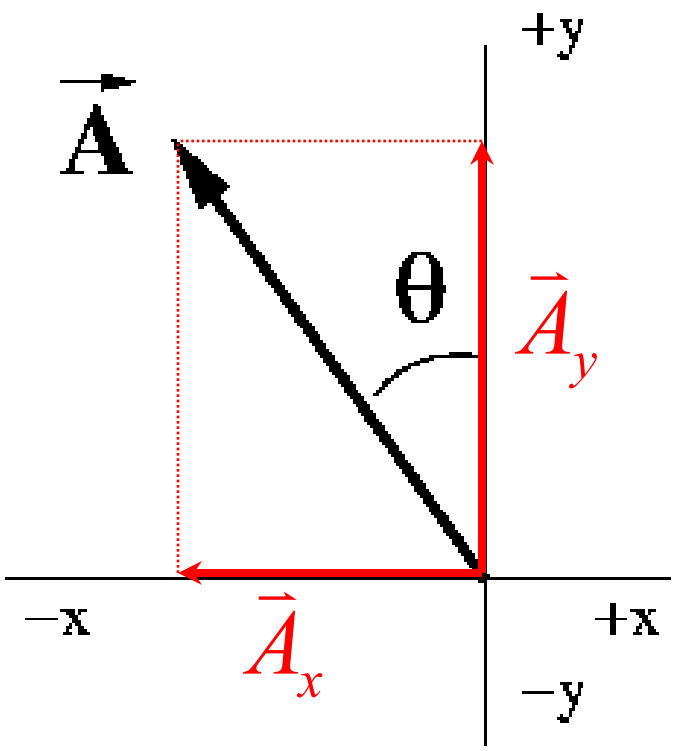
Can Reconstruct C from Components

Adding Vectors

- Choose Axes
- Find Components
- Add Components
- Reconstruct Resultant Vector



Sign of the components



- First: calculate the magnitude of the components.

$$\left|\vec{A}_x\right| = \left|\vec{A}\right| \sin\theta \qquad \left|\vec{A}_y\right| = \left|\vec{A}\right| \cos\theta$$

- Then, if the component vector is pointing in the negative direction of the axis, assign a minus sign.

$$A_x = -\left|\vec{A}\right| \sin\theta$$

$$A_y = +\left|\vec{A}\right| \cos\theta$$

$$\vec{A} = \left(A_x, A_y\right)$$

Example: Adding Vectors with Components

You drive 40 mi in a direction 25° North of East, then switch drivers.

Your friend then drives 25mi in a direction 60° North of West.

What is your total displacement?

- **Choose Axes**
- **Find Components**
- **Add Components**
- **Reconstruct Resultant Vector**

Ans: about 45.3 miles

How would you calculate the X component of the vector F?

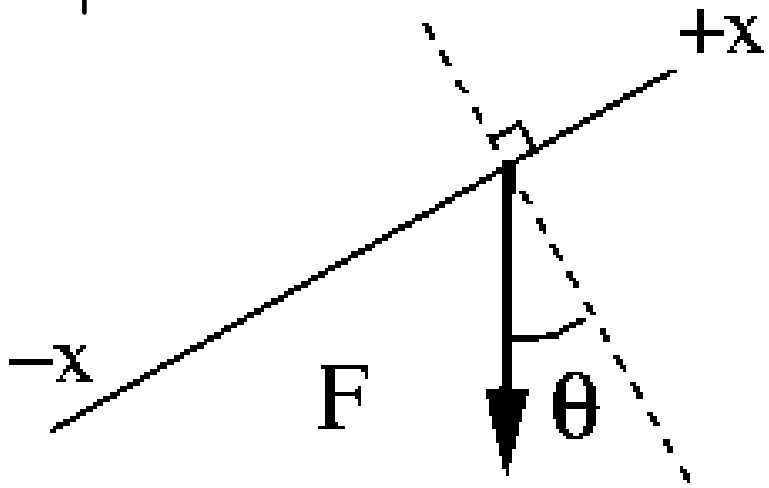
$$\left|\vec{F}_x\right| = \left|\vec{F}\right| \sin\theta$$

(1) $F_x = F \sin\theta$

(2) $F_x = -F \sin\theta$

(3) $F_x = F \cos\theta$

(4) $F_x = -F \cos\theta$



How would you calculate the X and Y components of the vector A?

(1) $A_x = A \sin\theta$; $A_y = A \cos\theta$;

(2) $A_x = -A \sin\theta$; $A_y = A \cos\theta$;

(3) $A_x = A \cos\theta$; $A_y = A \sin\theta$;

(4) $A_x = -A \cos\theta$; $A_y = A \sin\theta$;

(5) $A_x = A \cos\theta$; $A_y = -A \sin\theta$;

(6) $A_x = A \sin\theta$; $A_y = -A \cos\theta$;