Spring 2014

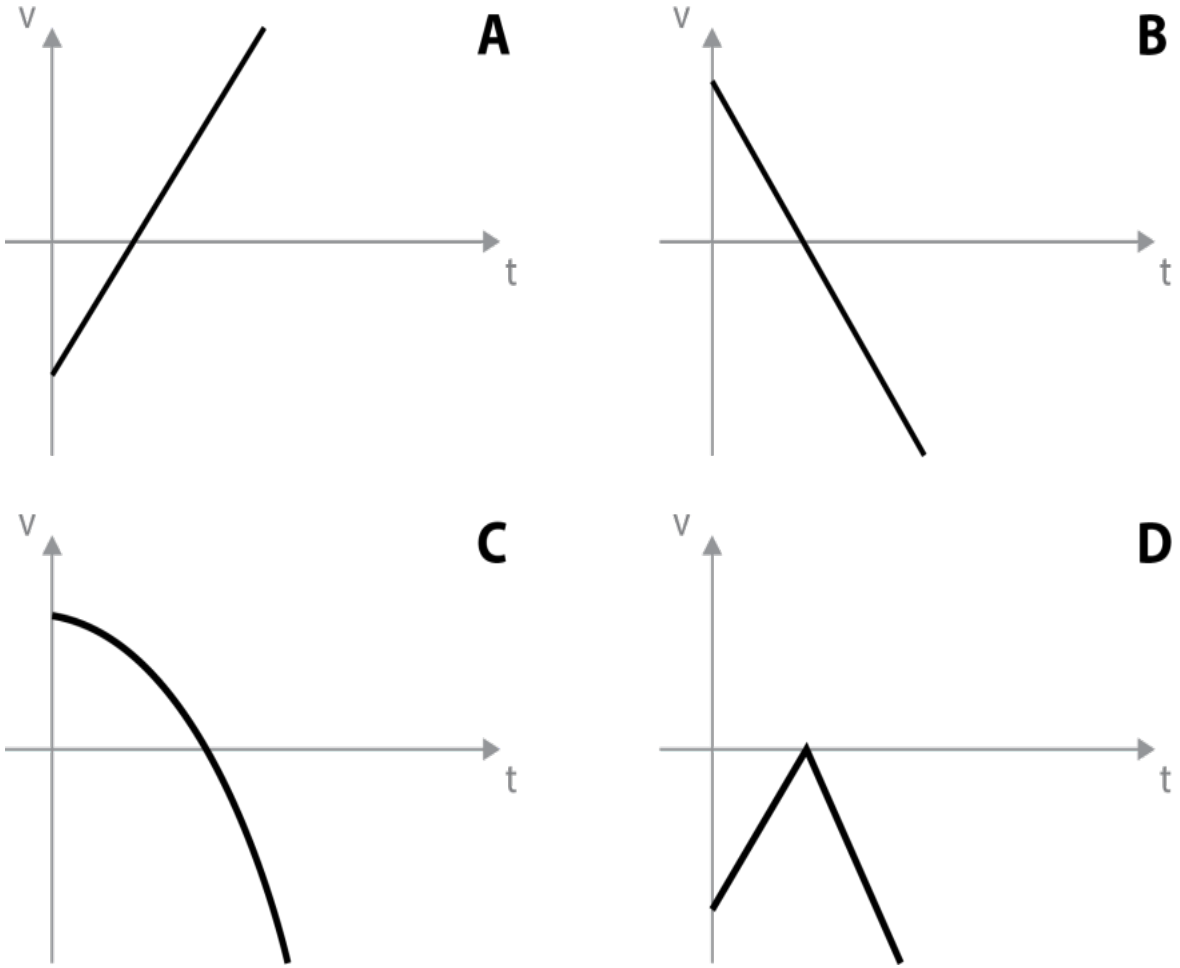
PHYS-2010

Lecture 8

Clicker Question

Room Frequency BA

I throw a ball up in the air (the ball leaves my hand at t=0) (+y is up). What does the velocity vs. time graph look like?



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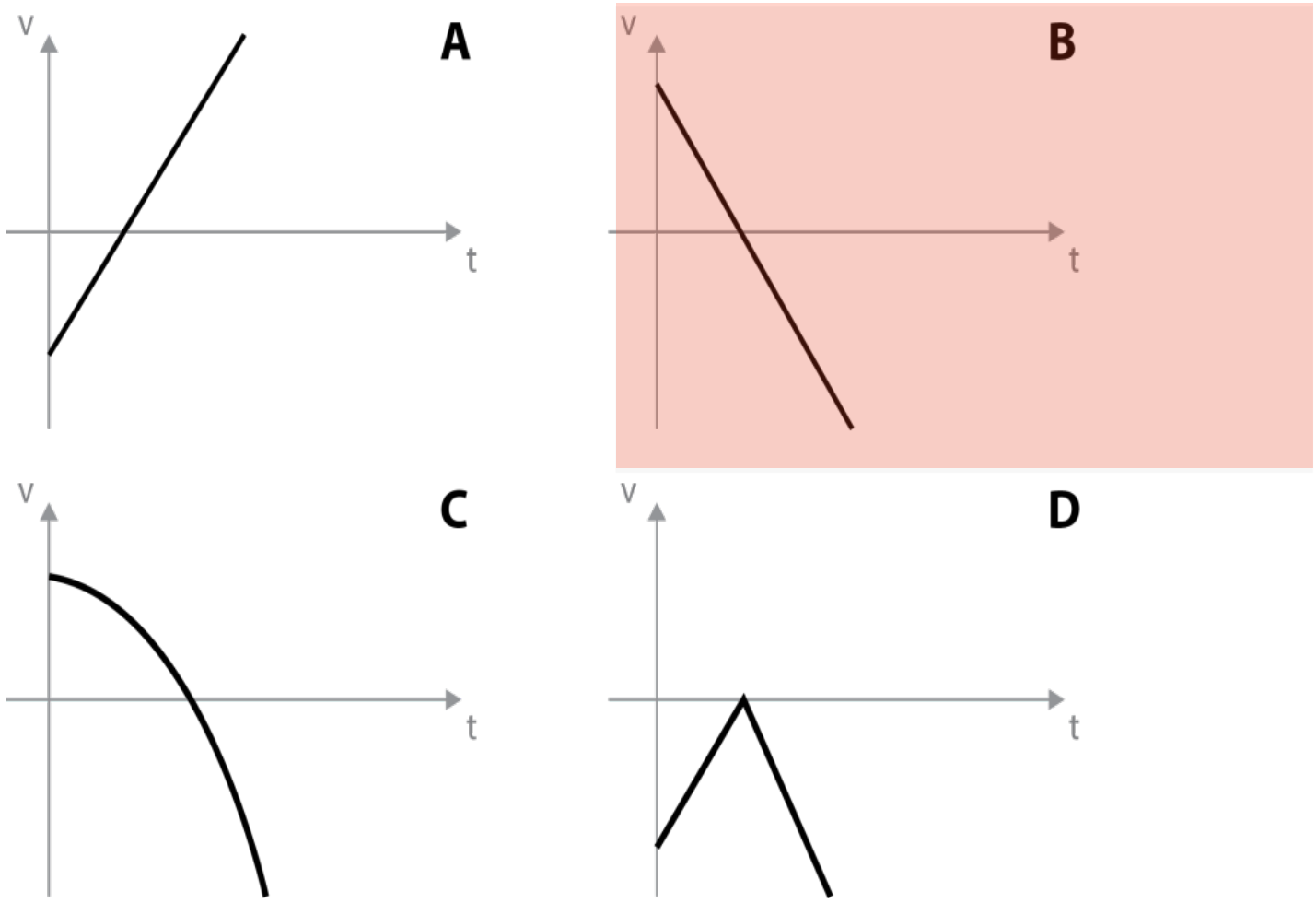


Announcements

- Read Giancoli Sections 3.1-3.5.
- **CAPA assignment # 3** is due next Tuesday at 11 pm.
- **Written homework # 2** is due today at 4 PM.
- **Midterm Exam 1** will be Thursday, Feb 6, 7:30-9:15 PM.
- **Practice exam** is posted on D2L.
- More details about the exam are on the next slide on the course website:

http://www.colorado.edu/physics/phys2010/phys2010_sp14/exams.html

- Special informal **review session** held by Rosemary Wulf on Tue. Feb. 4, 5-6:30 PM, in Duane G125.

Materials to study for Mid-Term I

- **Giancoli Ch.1 – Ch. 3.4**.
- In-class **Clicker Questions & Lecture Materials**.
- Your **CAPAs**.
- **Written Homeworks** 1 & 2.
- **Recitation Assignments and Lab**.
- **Giancoli web site**: "Practice Questions", "MCAT Study Guide", "Practice Problems". Link on course web site.
- Old **practice exam** posted on D2L.
- Dr. Michael **Dubson's Chapter Notes** (link on course website).

Last time …

We finished discussion of kinematics (description of motion) **in 1D** (Ch. 2):

- Definitions of position, displacement, velocity, acceleration.
- Constant acceleration equations.
- Graphs of position, velocity, acceleration vs. time.

New Topic:

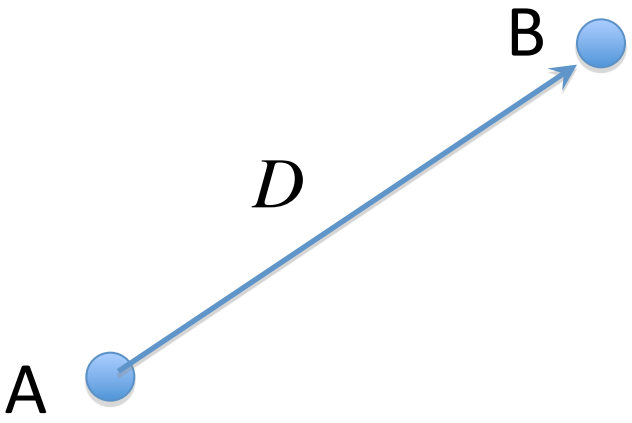
Vectors and 2-dimensional motion (Ch. 3)

Expressing motion in 2D: Vectors

Example: Displacement

"net effect of the motion"

represented with a ***vector***:



--- a mathematical object with a *"magnitude"* (length) and a *"direction"*.

Other examples of vectors:

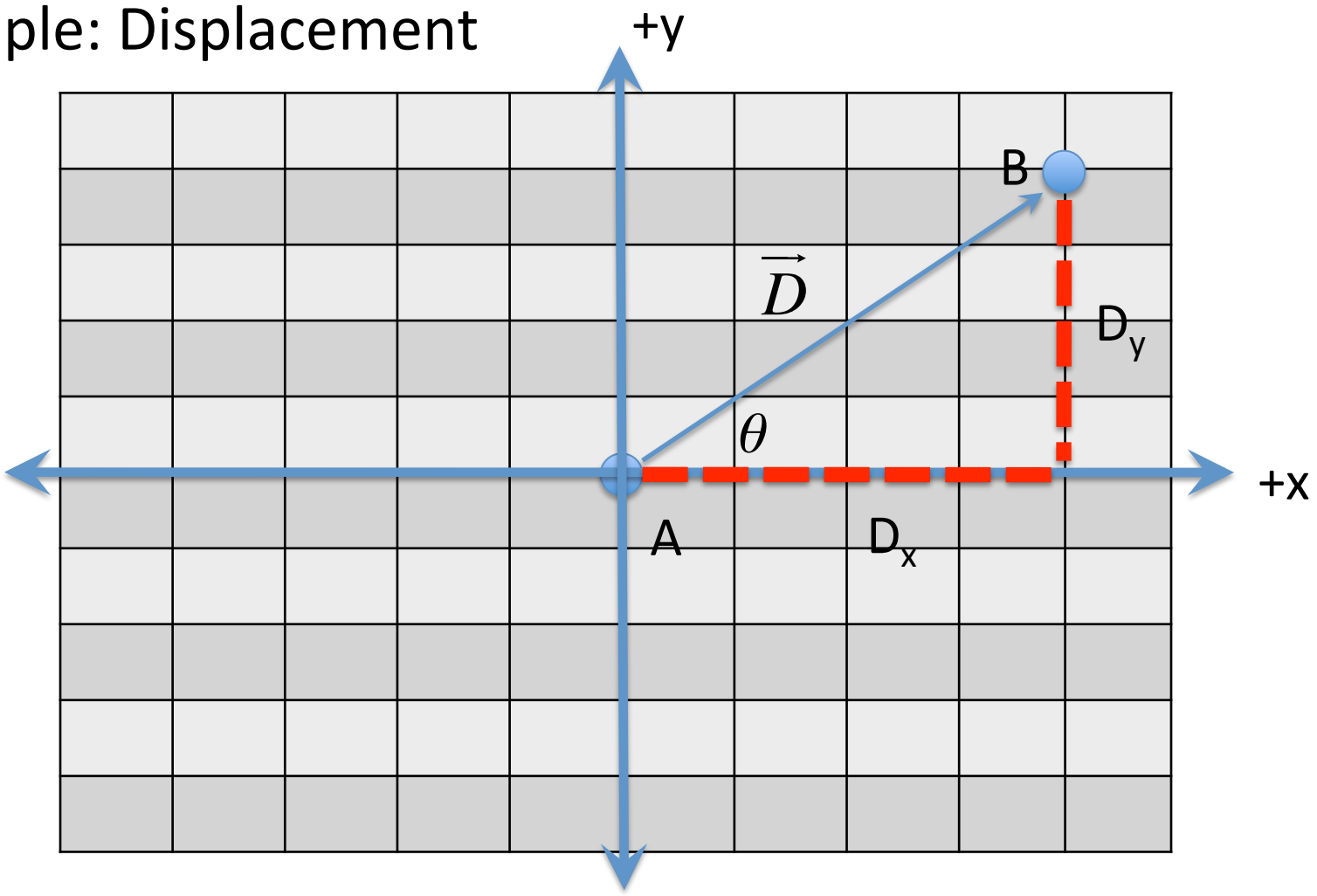
$$\vec{v},\ \vec{a},\ \vec{p},\ \vec{F}$$

Non-vector quantities are called "scalars":

$$E,\ m,\ W,\ T,\ \rho$$

Components of Vectors

Example: Displacement

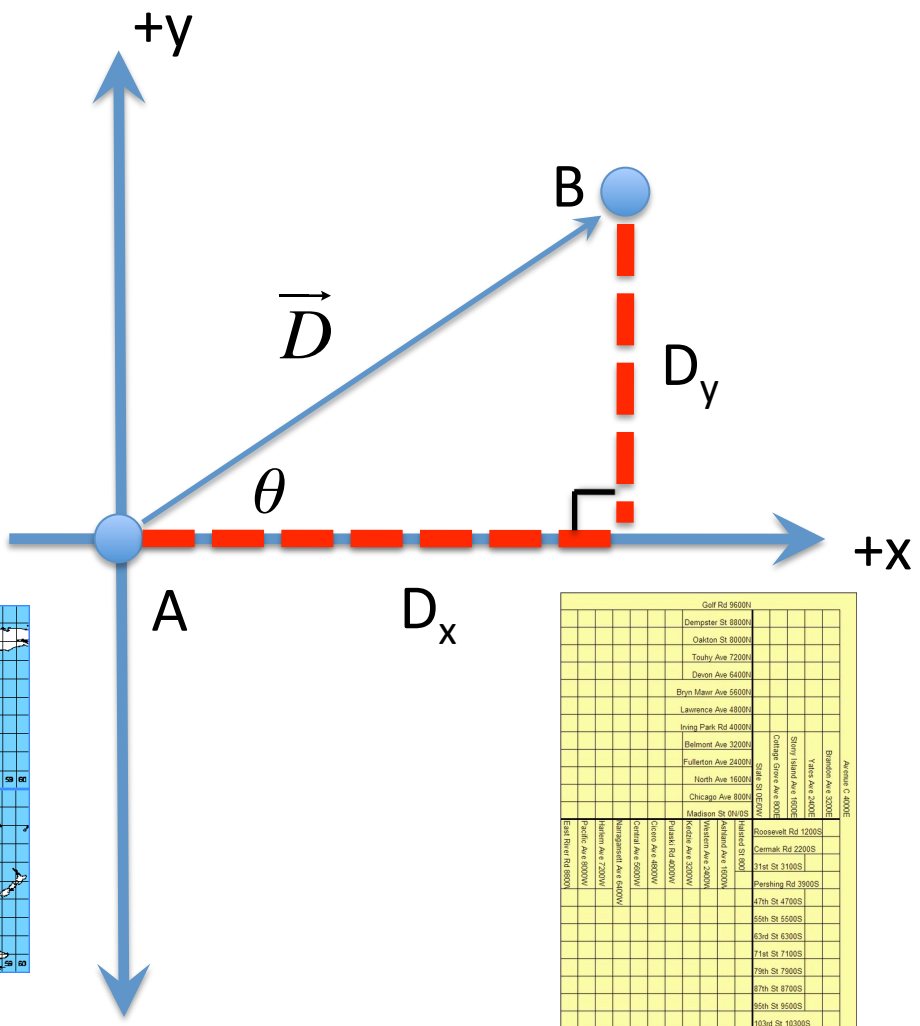


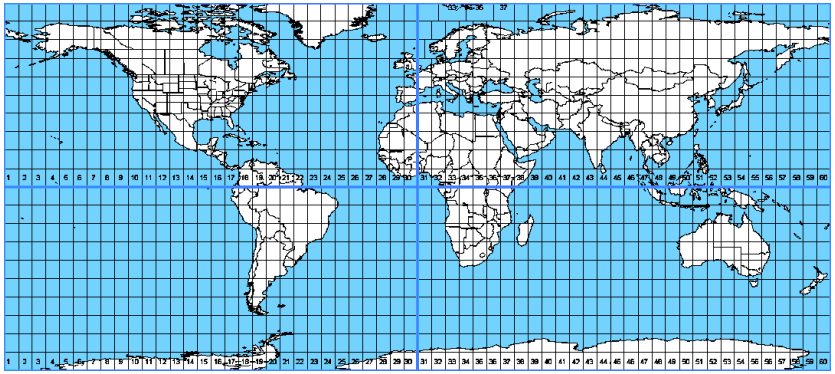
Vectors: Ordered Pairs

Example: Displacement

$$\vec{D} = (D_x, D_y)$$

Represented as an ordered pair of numbers called **vector components**





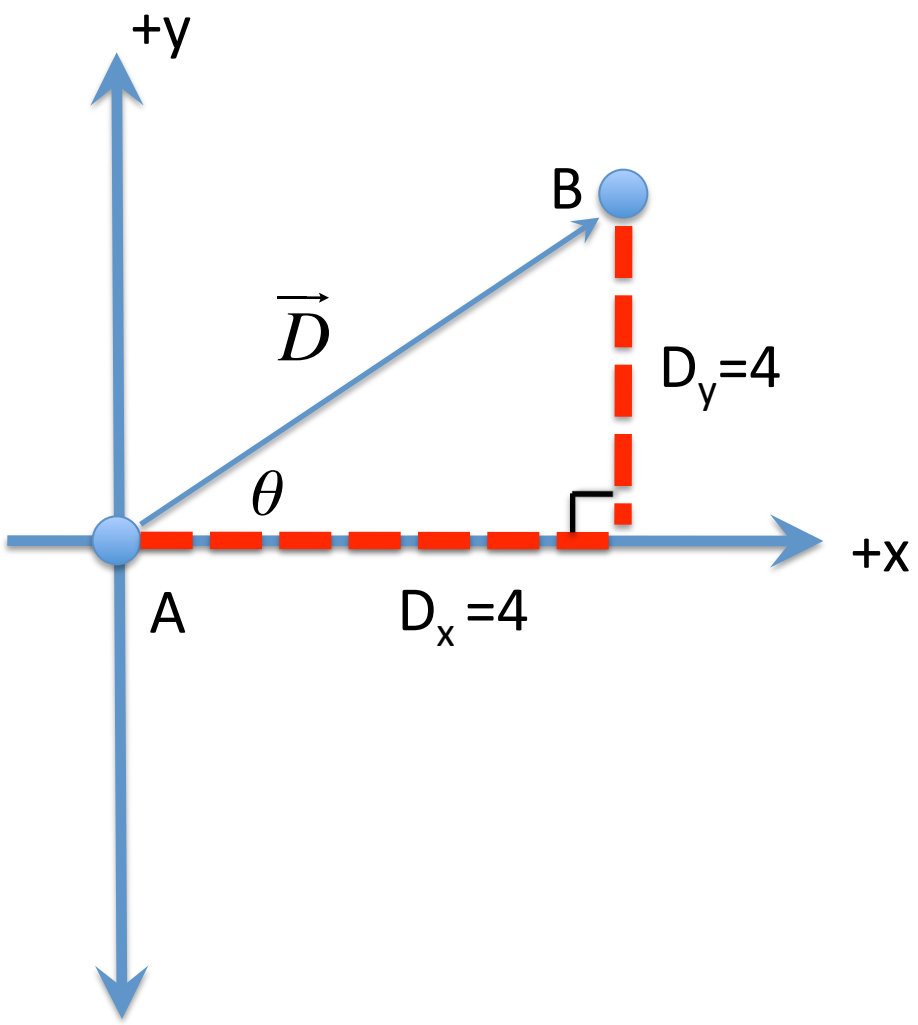
Magnitude from Vector Components

Example: Displacement

$$\vec{D} = (D_x, D_y) = (4,4)$$

$$D = |\vec{D}| = \sqrt{D_x^2 + D_y^2}$$

$$= \sqrt{32}$$



Pythagorean Theorem

Clicker Question

Room Frequency BA

A displacement vector $\vec{V}$ has has x-component V_x = 4 km and y-component V_y = 3 km.

What is the length (or magnitude) of the vector $\vec{V}$?

A) 5 km

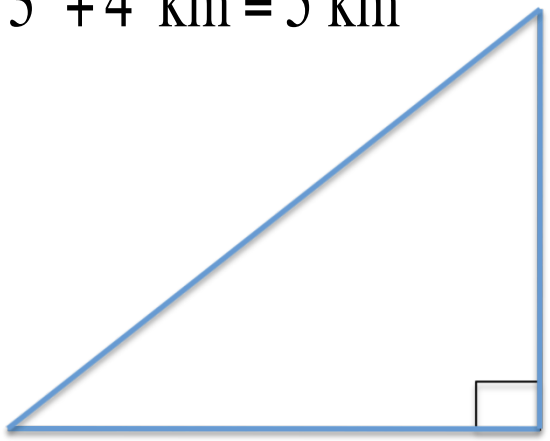
B) 16 km

C) 25 km

D) 32 km

E) 49 km

$$V = |\vec{V}| = \sqrt{3^2 + 4^2}\,\text{km} = 5\,\text{km}$$



Vector Components and Trigonometry

Example: Displacement

$$\vec{D} = (D_x, D_y) \leftrightarrow (|\vec{D}|, \theta)$$

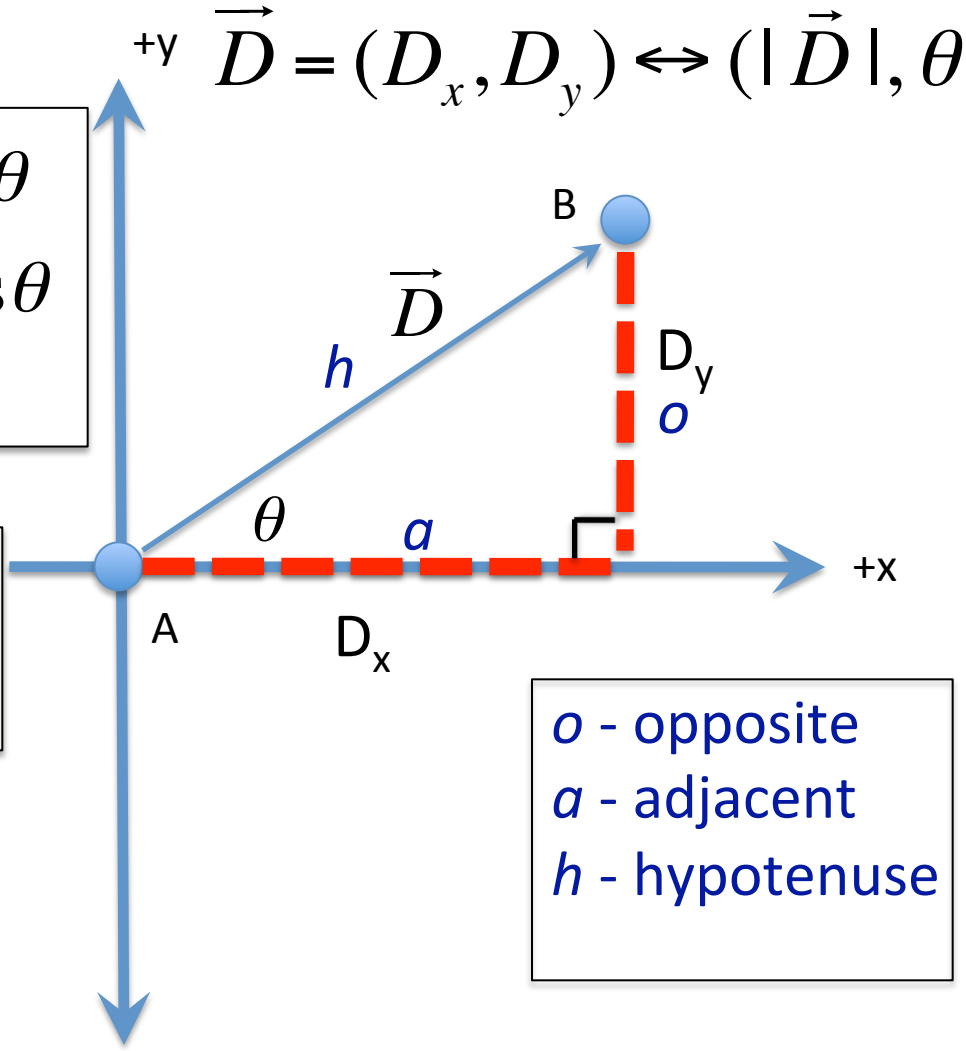
$$\sin\theta = \text{o} / \text{h} \rightarrow \text{o} = \text{h}\sin\theta$$

$$\cos\theta = \text{a} / \text{h} \rightarrow \text{a} = \text{h}\cos\theta$$

$$\tan\theta = \text{o} / \text{a}$$

$$\theta = \tan^{-1}(\text{o} / \text{a})$$

= "angle whose tangent is o/a"



o - opposite
a - adjacent
h - hypotenuse

Angles measured in degrees or radians:

2π rad = 360°

Clicker Question

Room Frequency BA

Angle θ = π/4 radians. What is the measure of θ in degrees?

A) 30°
B) 45°
C) 60°
D) 90°
E) 180°

π = 180 deg

π/4 = 180/4 = 45 deg

Clicker Question

Room Frequency BA

Consider the triangle below. Which one of the following is correct?

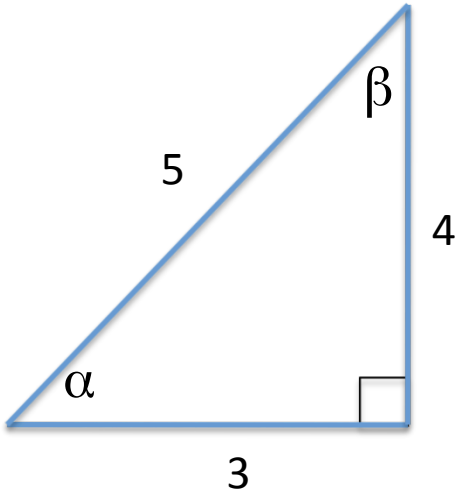
A) $\cos \alpha = 4/5$

B) $\sin \alpha = 3/5$

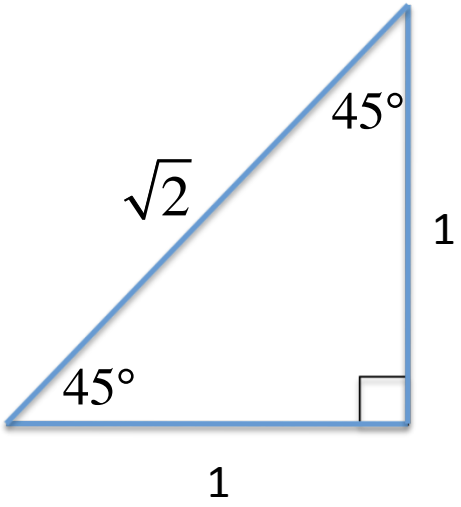
C) $\sin \beta = 4/5$

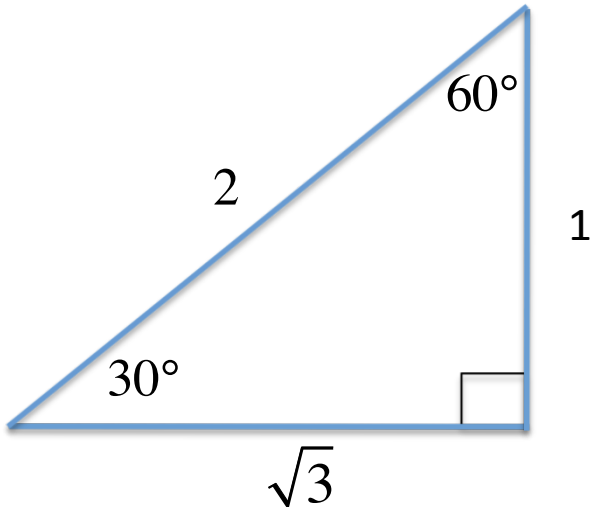
D) $\cos \beta = 3/4$

E) $\tan \alpha = 4/3$



Special Triangles:





$$\sin 60^\circ = \frac{\sqrt{3}}{2} \qquad \cos 45^\circ = \frac{1}{\sqrt{2}}\left(\frac{\sqrt{2}}{\sqrt{2}}\right) = \frac{\sqrt{2}}{2}$$

Components ⟷ Length, Angle

$$\vec{D} = (D_x, D_y) = (4,4)$$

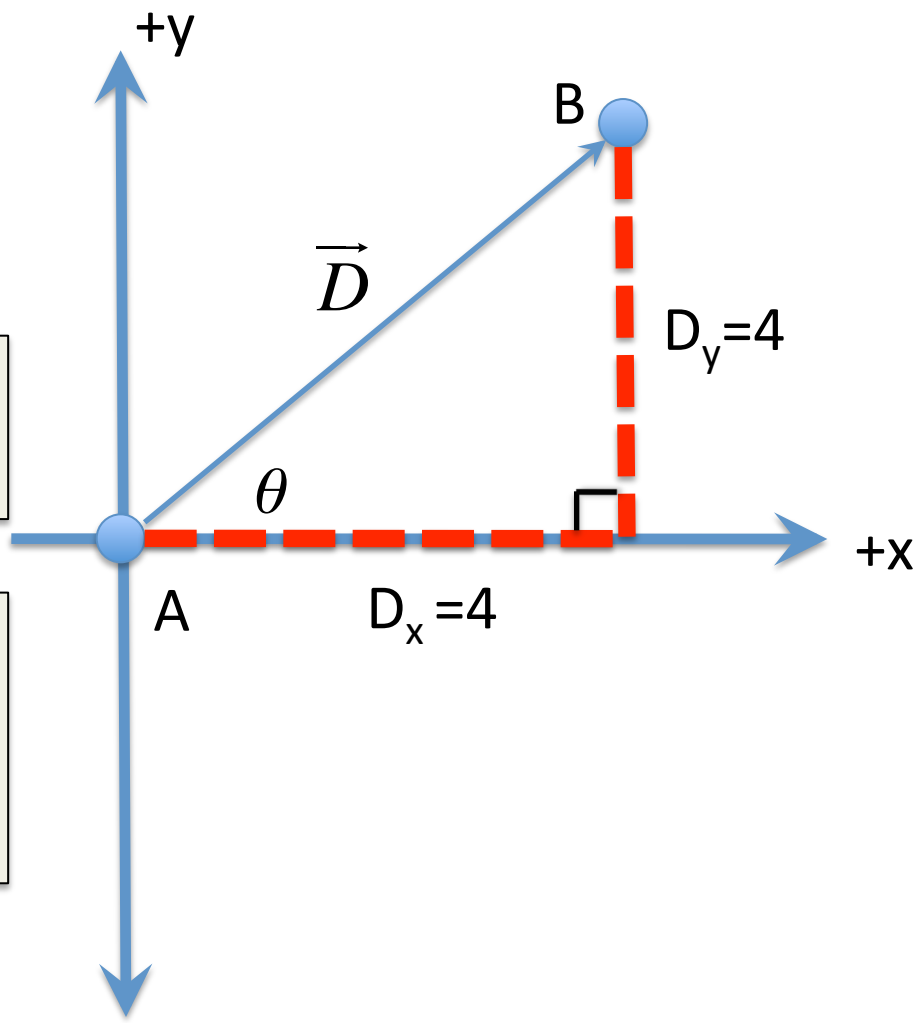
$$D = |\vec{D}| = \sqrt{D_x^2 + D_y^2} = \sqrt{32}$$

(Pythagorean Theorem)

$$\theta = \tan^{-1}\left(\frac{D_y}{D_x}\right) = \tan^{-1}(1) = \frac{\pi}{4} = 45^\circ$$

$$D_x = |\vec{D}|\cos\theta \quad \& \quad D_y = |\vec{D}|\sin\theta$$

$$= \sqrt{32}\frac{\sqrt{2}}{2} \qquad = \sqrt{32}\frac{\sqrt{2}}{2}$$



Clicker Question

Room Frequency BA

What is the correct formula for A_y, the *y*-component of the vector? (Note: A > 0 is the length of the vector.)

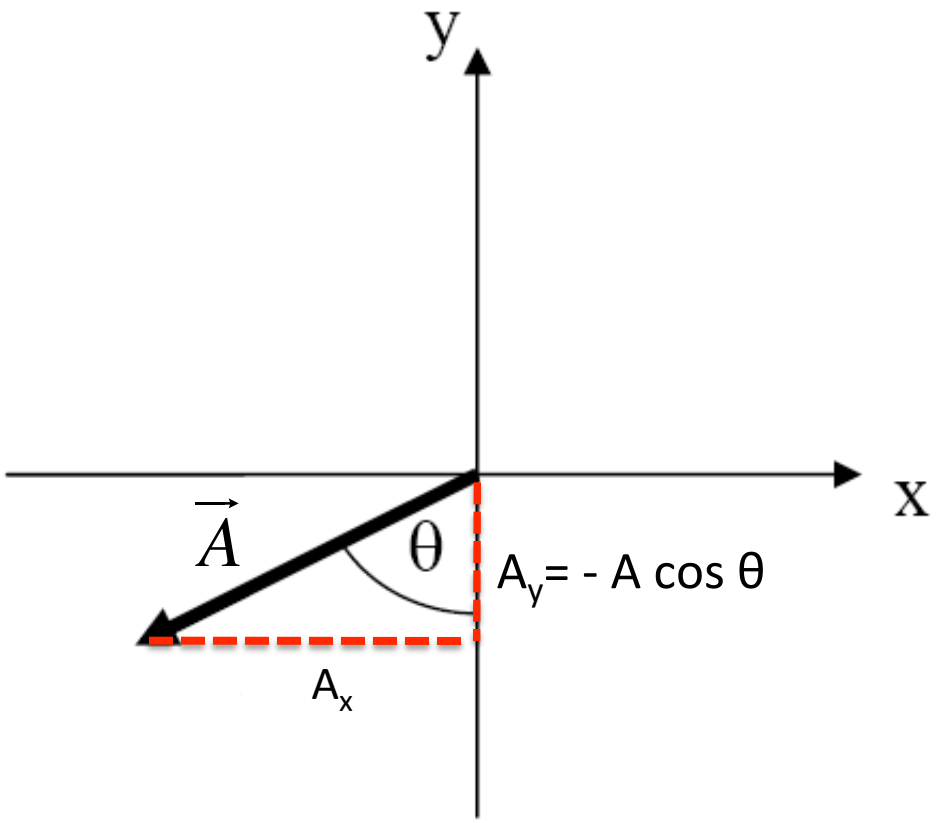
A) +A cosθ

B) +A sinθ

C) –A cosθ

D) –A sinθ

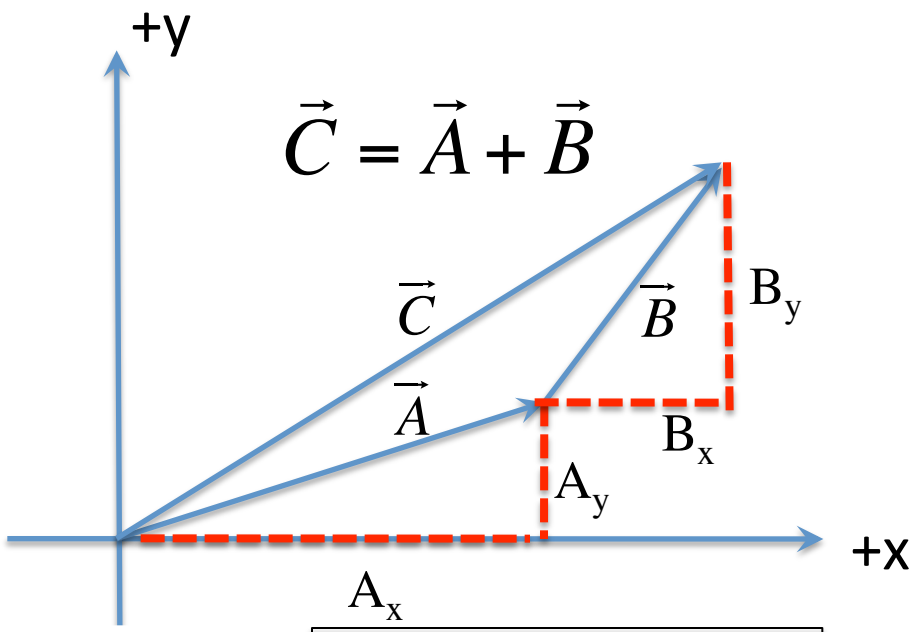
E) None of these.



Vector Addition I

Add components:

$$\vec{C} = \vec{A} + \vec{B}$$
$$= (A_x, A_y) + (B_x, B_y)$$
$$= (A_x + B_x, A_y + B_y)$$



Head-to-Tail graphical interpretation

For example, walk E 3 blks & N 2 blks.
Then walk E 2 blks & N 4 blks.
Result: E 5 blks & N 6 blks.