Spring 2014

PHYS-2010

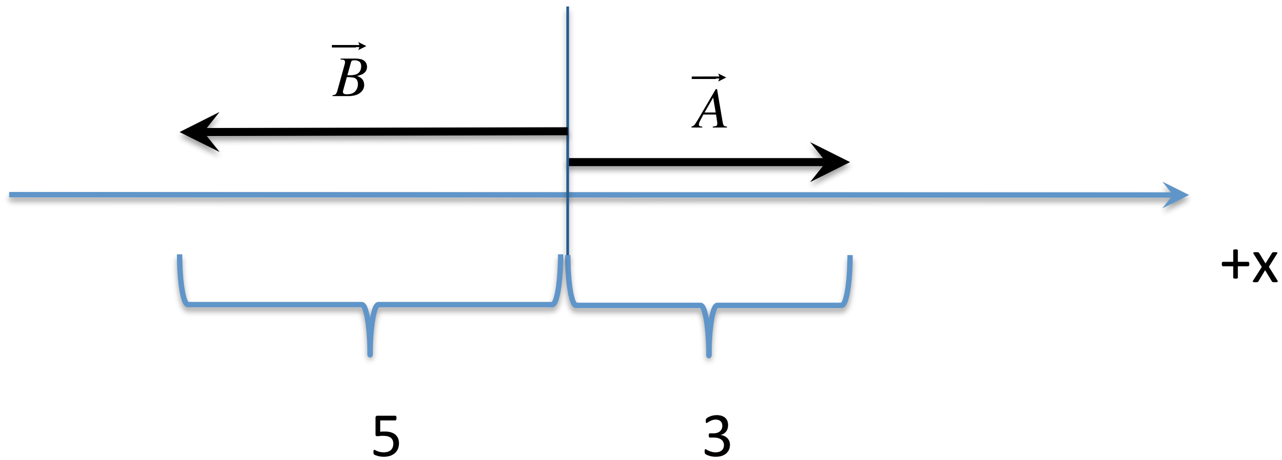
Lecture 9

Clicker Question

Room Frequency BA

Vector $\vec{A}$ has magnitude 3 and points in the positive x-direction (right).

Vector $\vec{B}$ has magnitude 5 and points in the negative x-direction (left).



What is the magnitude of the vector $\vec{A} + \vec{B}$?

A) 2 B) -2 C) 8 D) -8 E) 5

Clicker Question

Room Frequency BA

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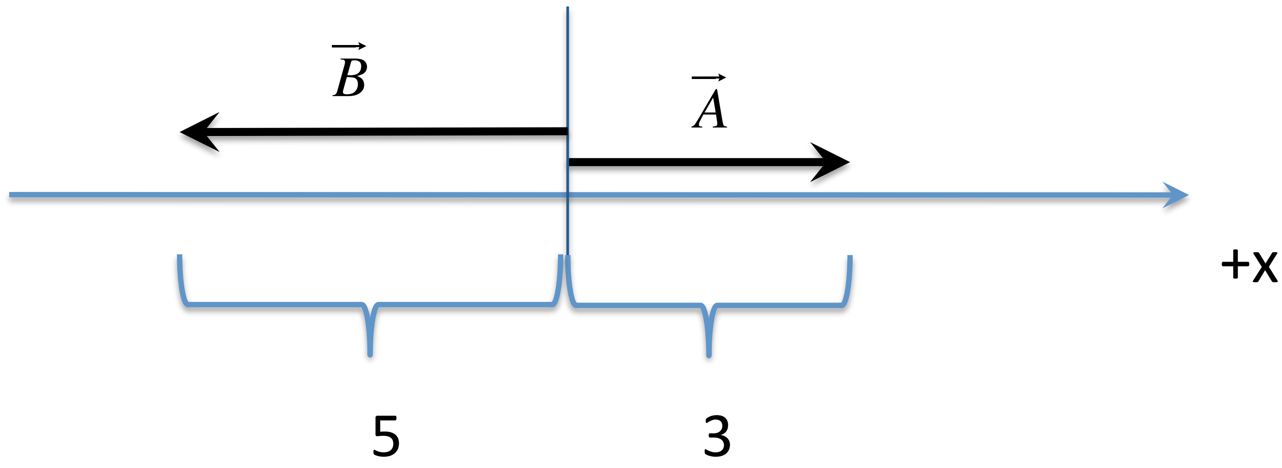


What is the magnitude of the vector $\vec{A} + \vec{B}$?

A) 2   B) -2   C) 8   D) -8   E) 5

A = (3,0), B = (-5,0), A + B = (-2,0), |A + B| = 2

Announcements

- Read Giancoli Sections 3.1-3.5.
- **CAPA assignment # 3** is due Tuesday at 11 pm.
- **No Written homework** this week!
- **Midterm Exam 1** will be Thursday, Feb 6, 7:30-9:15 PM.
- Exam seating:
  - if your TA is Rosemary Wulf or Andrew Hess, your exam is here, G1B30.
  - if your TA is Jake Fish or Clarissa Briner, your exam is next door, G1B20.
- More details about the exam are 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.

Good Exam Habits

- Get a good night's sleep before and try to stay calm!
- Follow the instructions on the front page of the exam.
- Read through the exam quickly to identify "easy" problems and "hard" problems; do the easy ones first.
- Read the problems carefully; ask a proctor if you are unsure what the problem is asking.
- If you get stuck on a question, move on, and return to the problem later.
- Check your answers with simple estimates and make sure they have the correct units.

Components ←→ Length, Angle

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

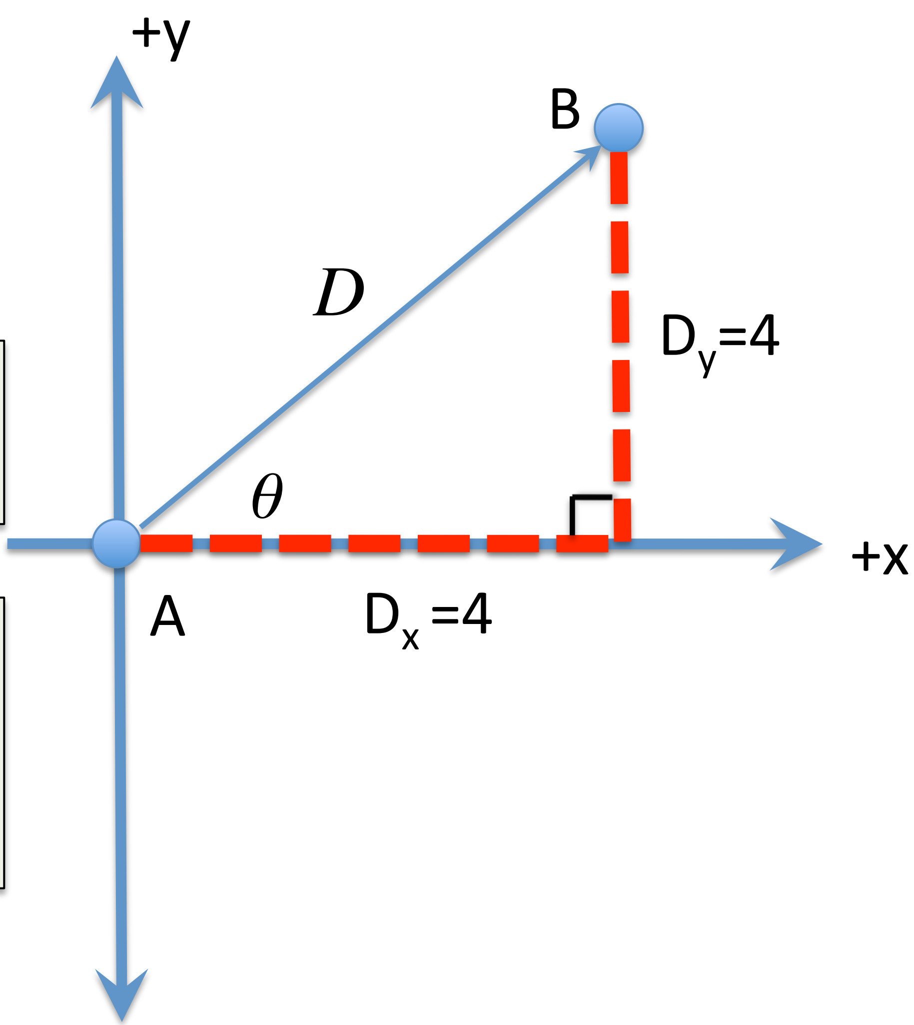
$$D = |\vec{D}| = \sqrt{D_x^2 + D_y^2} = \sqrt{32}$$

(Pythagorean Theorem)

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

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

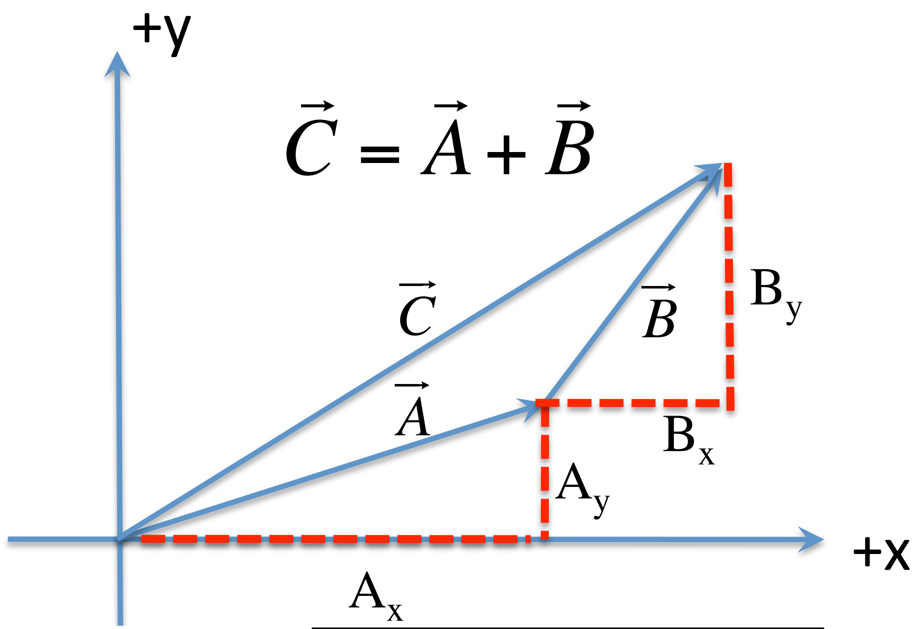
$$= \sqrt{32}\,\frac{\sqrt{2}}{2} \qquad\qquad = \sqrt{32}\,\frac{\sqrt{2}}{2}$$



Vector Addition I

Add components:

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



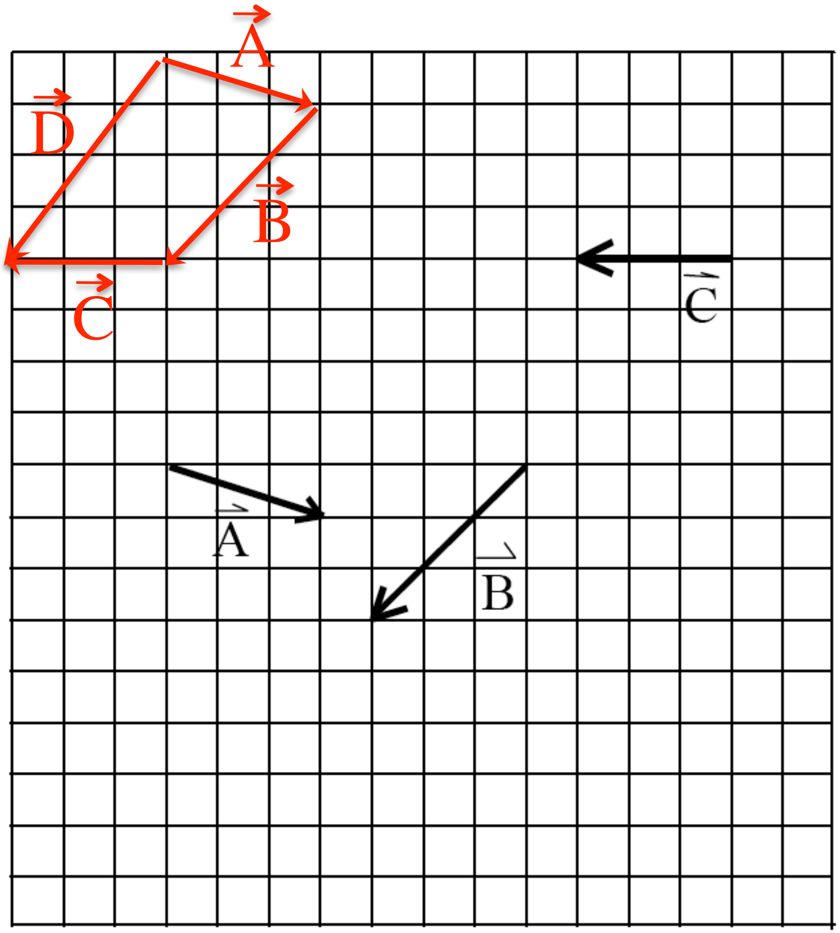
Head-to-Tail graphical interpretation

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

Clicker Question

Room Frequency BA

Consider the vectors $\vec{A}$, $\vec{B}$, and $\vec{C}$ below. If $\vec{D} = \vec{A} + \vec{B} + \vec{C}$. What's $\vec{D}$?



A) $\vec{D} = (3, 3)$

B) $\vec{D} = (-3, -4)$

C) $\vec{D} = (-2, 3)$

D) $\vec{D} = (-3, -3)$

E) $\vec{D} = (2, 4)$

$\vec{A} = (3, -1)$

$\vec{B} = (-3, -3)$

$\vec{C} = (-3, 0)$

$\vec{D} = (-3, -4)$

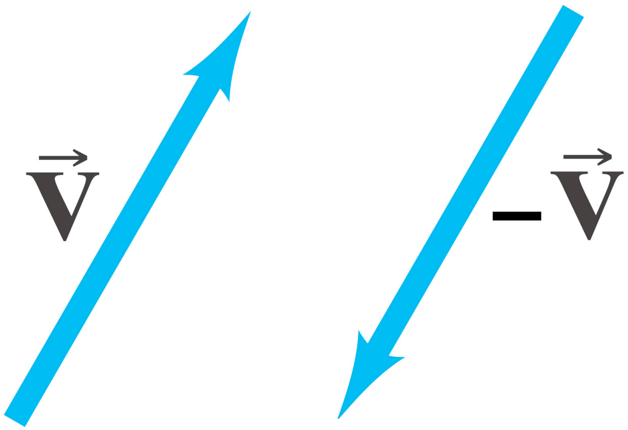
Vector Subtraction

Now subtract components:

$$\vec{C} = \vec{A} - \vec{B} = \vec{A} + (\overrightarrow{-B})$$

$$= (A_x, A_y) + (-B_x, -B_y)$$

$$= (A_x - B_{x,} A_y - B_y)$$



The negative of a vector is a vector having the same length but opposite direction.

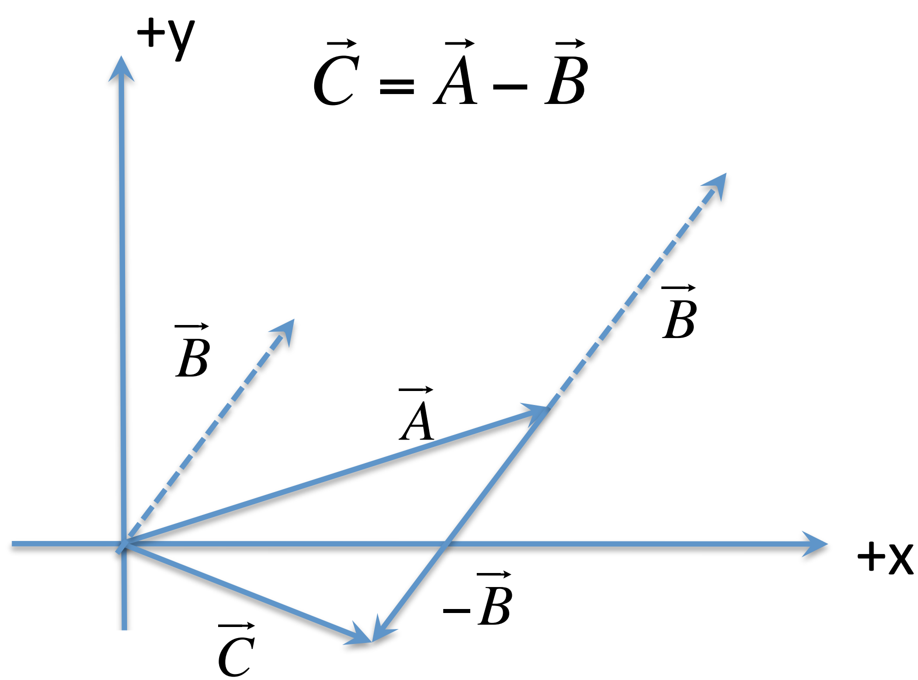
Vector Subtraction

Subtract components:

$$\vec{C} = \vec{A} - \vec{B} = \vec{A} + (\overrightarrow{-B})$$

$$= (A_x, A_y) + (-B_x, -B_y)$$

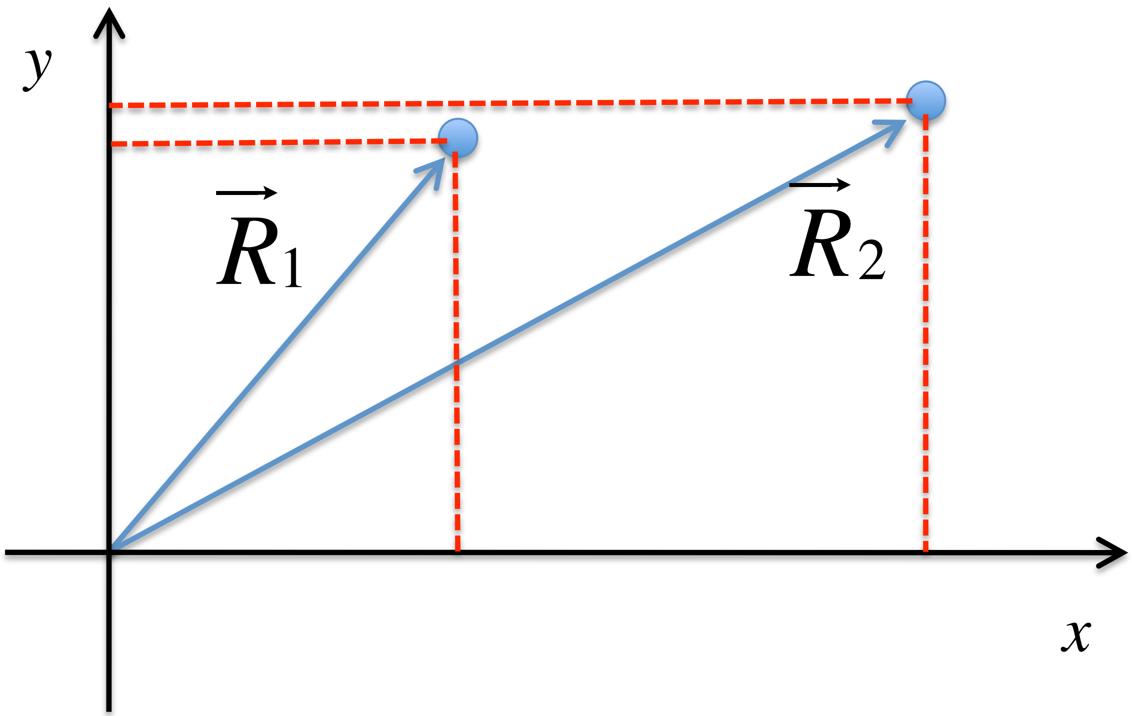
$$= (A_x - B_x, A_y - B_y)$$



Head-to-Tail graphical interpretation

Kinematics in 2D: Use of Vectors

Consider the two "position vectors" that specify the location of a blue ball at two points in time (t_1 and t_2) in a chosen (x,y) Reference Frame:



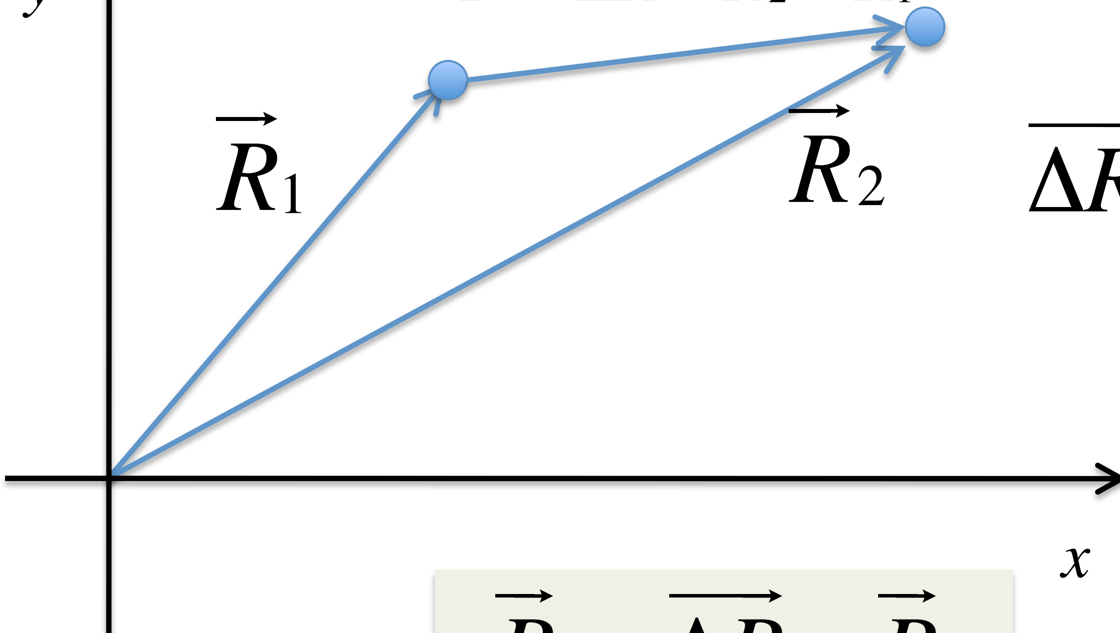
$$\vec{R}_1 = (r_{1_x}, r_{1_y})$$

$$\vec{R}_2 = (r_{2_x}, r_{2_y})$$

Kinematics in 2D: Use of Vectors

Consider the two “position vectors” that specify the location of a blue ball at two points in time (t_1 and t_2) in a chosen (x,y) Reference Frame:

$$\vec{D} = \overrightarrow{\Delta R} = \vec{R}_2 - \vec{R}_1$$

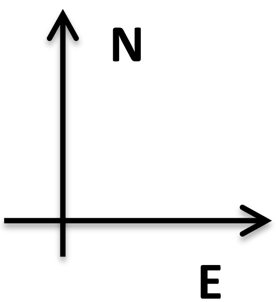


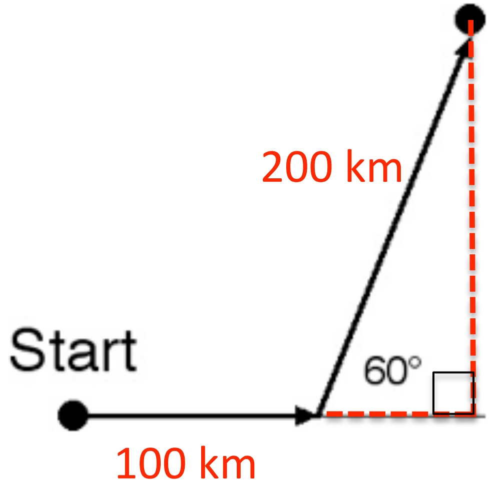
$\overrightarrow{\Delta R}$ = the displacement vector.

magnitude
and direction

$$\vec{R}_1 + \overrightarrow{\Delta R} = \vec{R}_2$$

You travel East in an airplane for 100 km. You then turn left 60 degrees (toward North) and fly 200 km.

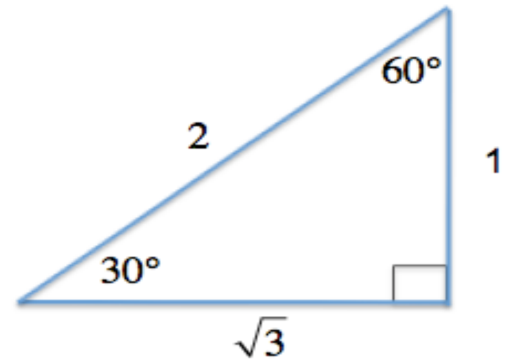




$y = 200\,(\sin 60°)$ km

$= 200(\sqrt{3}/2)$ km

$= 173$ km



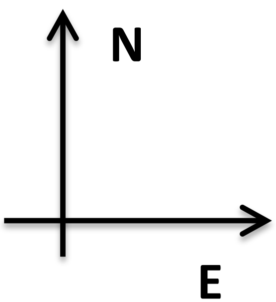
About how far **north** of your starting point will you be?

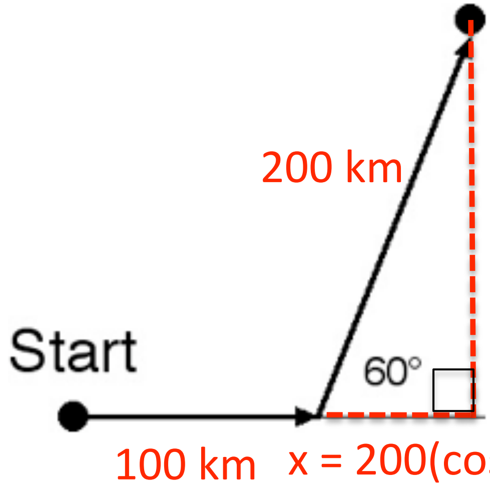
A) 100 km B) 170 km C) 200 km D) 265 km E) 370 km

Clicker Question

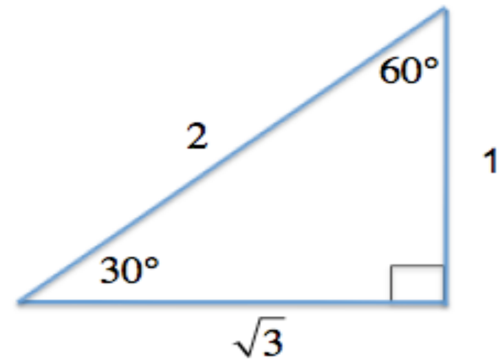
Room Frequency BA

You travel East in an airplane for 100 km. You then turn left 60 degrees (toward North) and fly 200 km.





$x = 200(\cos 60°)$ km $= 200(1/2)$ km $= 100$ km



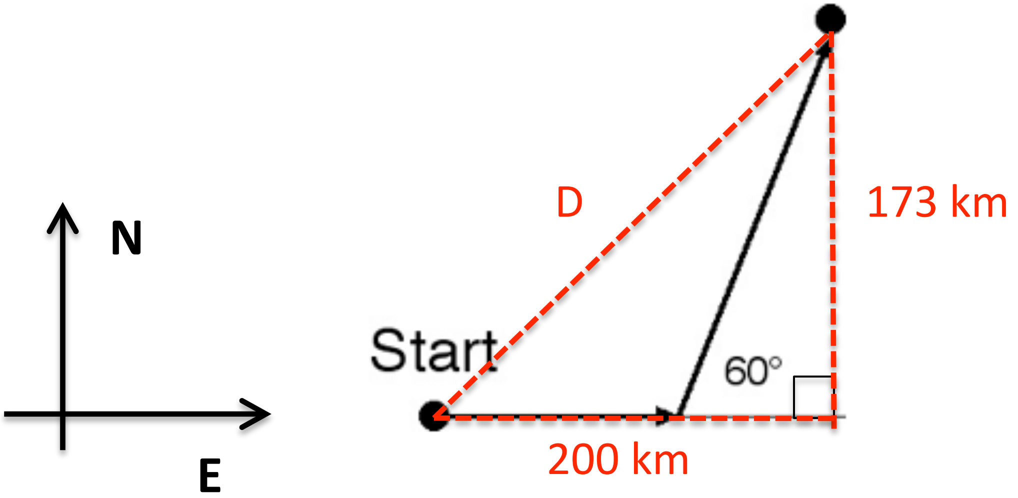
About how far **east** of your starting point will you be?

A) 100 km B) 170 km C) 200 km D) 265 km E) 370 km

Clicker Question

Room Frequency BA

You travel East in an airplane for 100 km. You then turn left 60 degrees (toward North) and fly 200 km.



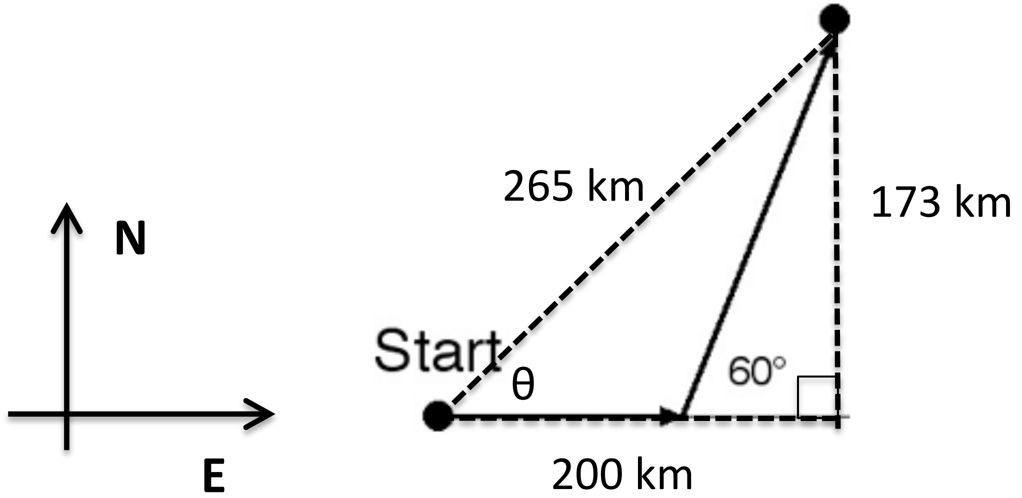
About how far from of your starting point will you be?

A) 100 km B) 170 km C) 200 km D) 265 km E) 370 km

$D = (200^2 + 173^2)^{1/2}$ km = 264.4 km

Pythagorean Theorem

You travel East in an airplane for 100 km. You then turn left 60 degrees (toward North) and fly 200 km.



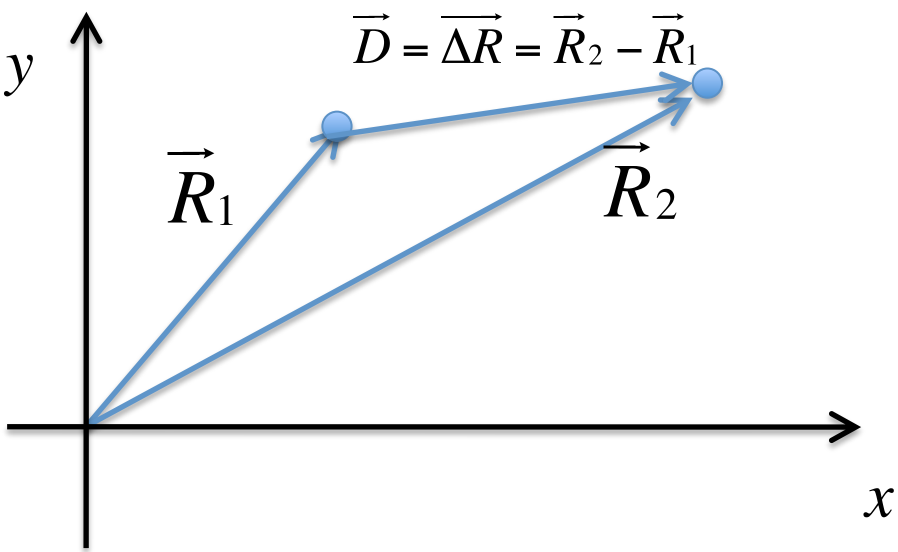
What will be the angle θ from your starting point?

A) 28° B) 37° C) 41° D) 47° E) 53°

$\theta = \tan^{-1}(173/200) = 40.9°$

Kinematics in 2D: Use of Vectors

Consider the two "position vectors" that specify the location of a blue ball at two points in time (t_1 and t_2) in a chosen (x,y) Reference Frame:



In 1D:

$$v = \frac{\Delta x}{\Delta t} = \frac{\text{displacement}}{\text{elapsed time}}$$

In 2D:

$$\vec{v} = \frac{\overrightarrow{\Delta R}}{\Delta t} = \frac{\text{displacement}}{\text{elapsed time}}$$

Note: in 2D:

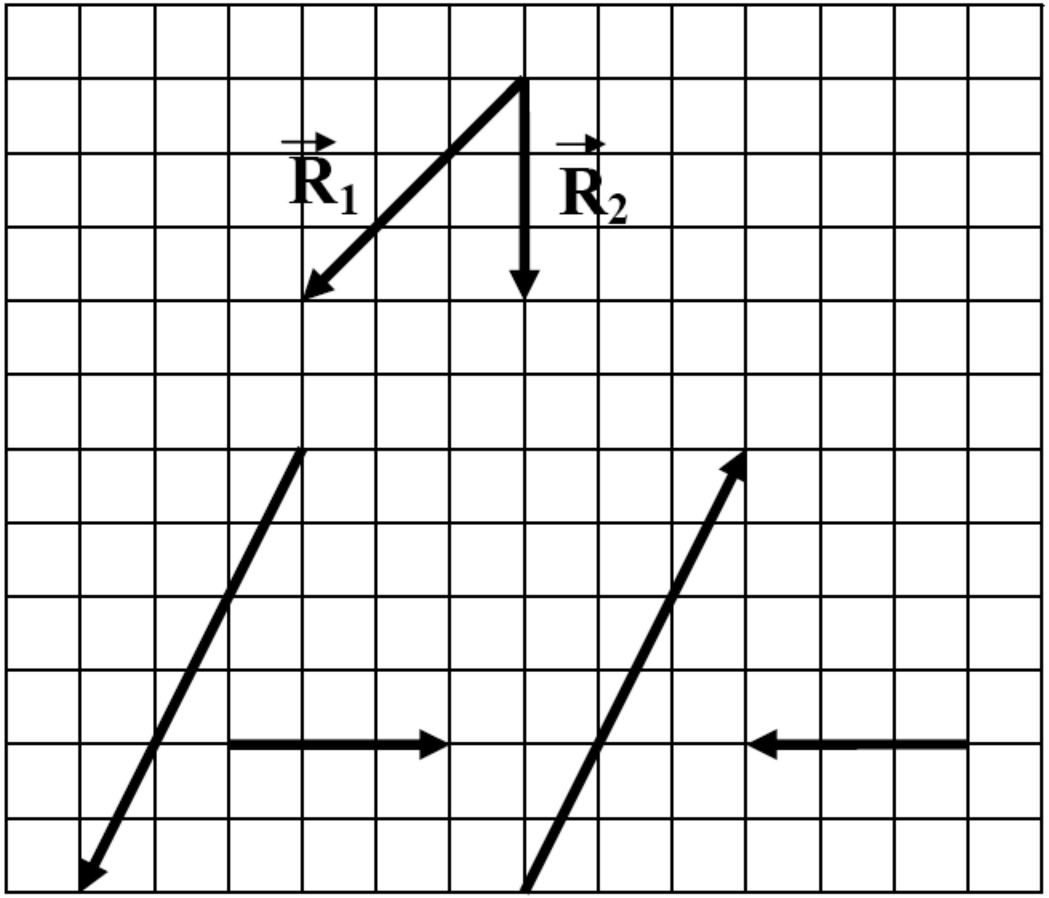
(1) **Velocity is a vector.**

(2) Direction of velocity is determined entirely by displacement.

Clicker Question

Room Frequency BA

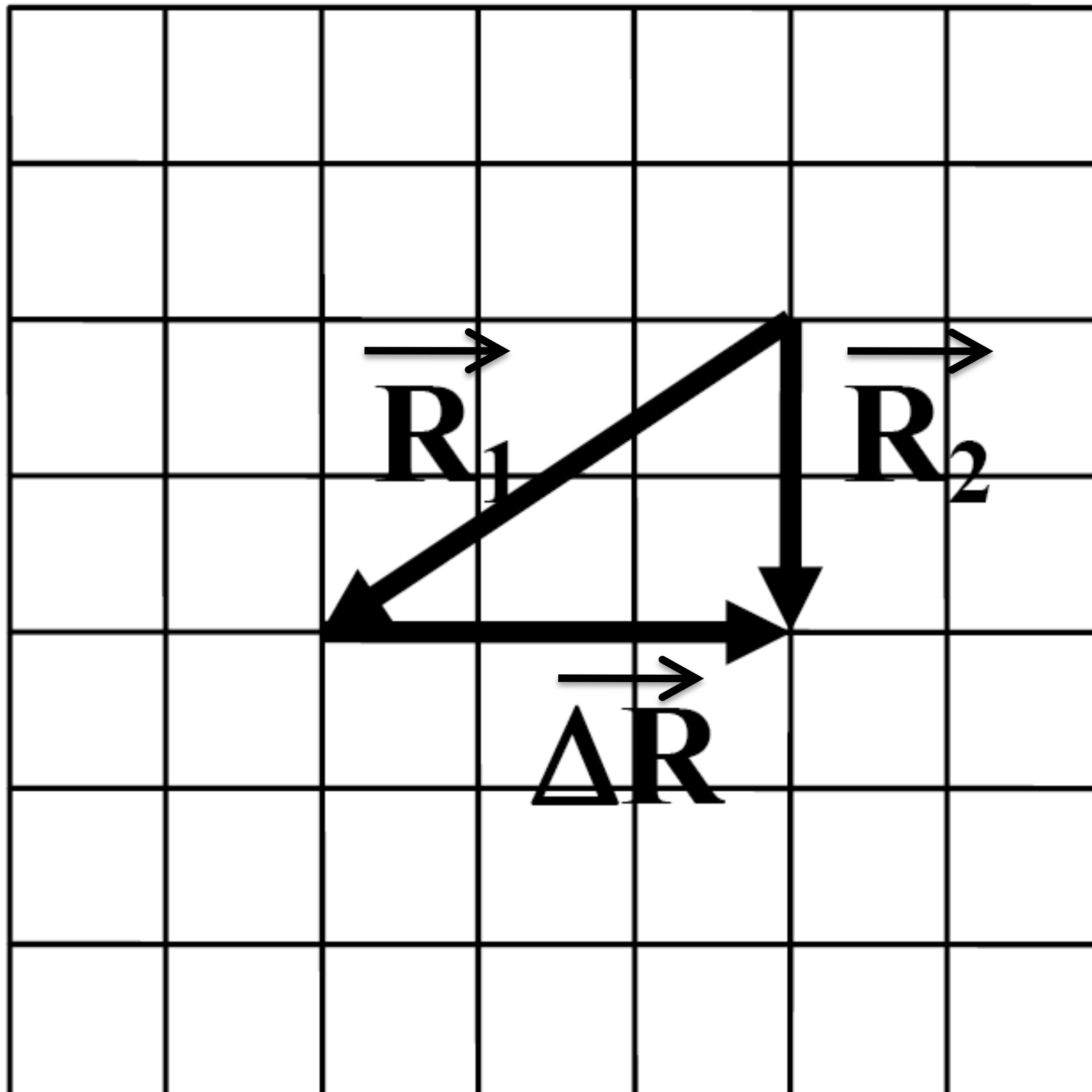
CT3-9. The position vector of a particle moving with constant velocity is shown below at two different times, an earlier time t_1 and a later time t_2. Which arrow shows the direction of the velocity vector?



(A) (B) (C) (D)

(E) None of these!

Answer: B) $\vec{v} = \frac{\Delta\vec{R}}{\Delta t}$



Note:

The velocity vector is in the direction of the displacement.

Kinematics in 2D: Use of Vectors

Speed vs. Velocity in 2D:

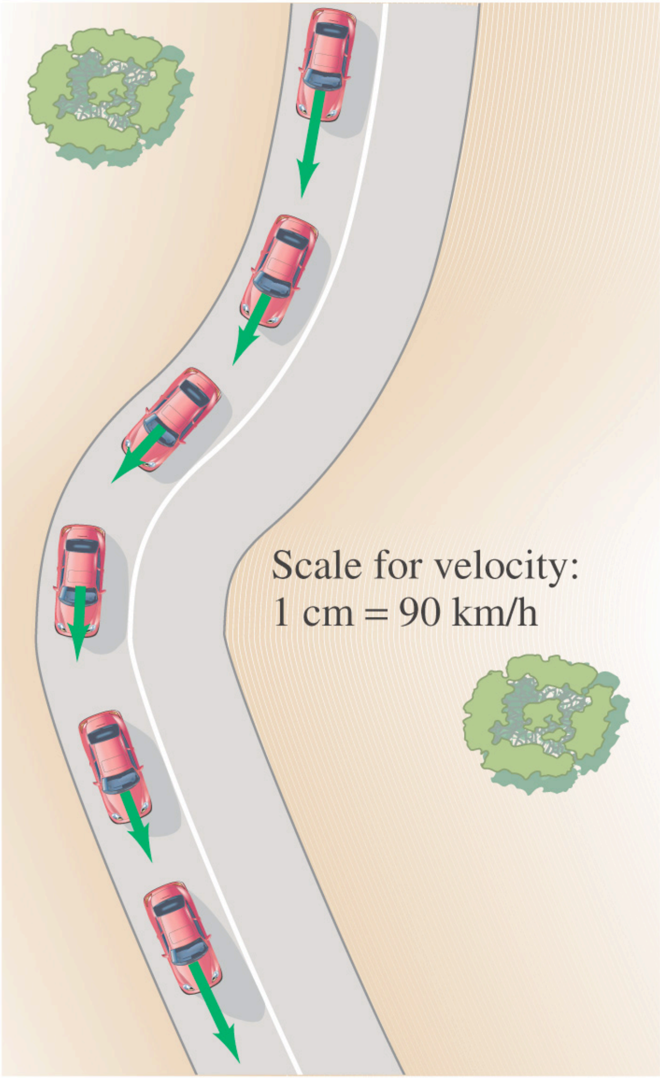
Velocity (vector)

$$\vec{v} = \frac{\Delta\vec{R}}{\Delta t} = \frac{\text{displacement}}{\text{elapsed time}}$$

Speed (scalar)

$$s = \frac{\text{distance traveled}}{\text{elapsed time}}$$

Velocity is changing but speed is constant.

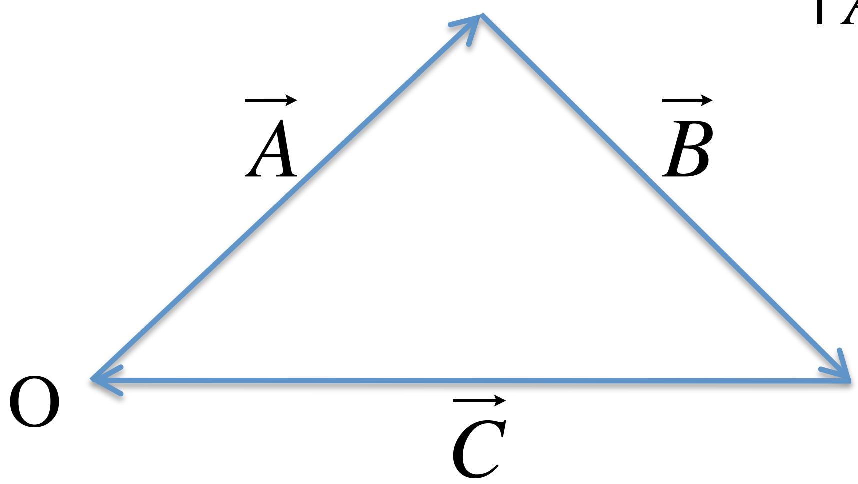


Clicker Question

Room Frequency BA

An object travels from point O back to point O in 1 hour along an equilateral triangle in which each side is 10 km as follows:

$$|\vec{A}| = |\vec{B}| = |\vec{C}| = 10 \text{ km}$$



What is the object's **average speed** around the loop?

A) 0 km/h
B) 10 km/h
C) 20 km/h
D) 30 km/h
E) 40 km/h

s = distance traveled/elapsed time
= 30 km/1 hr = 30 km/h