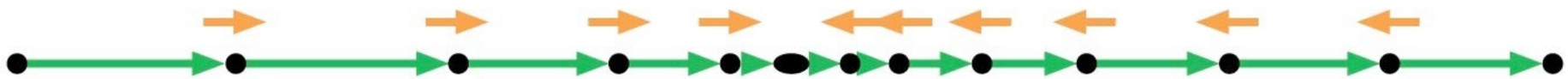
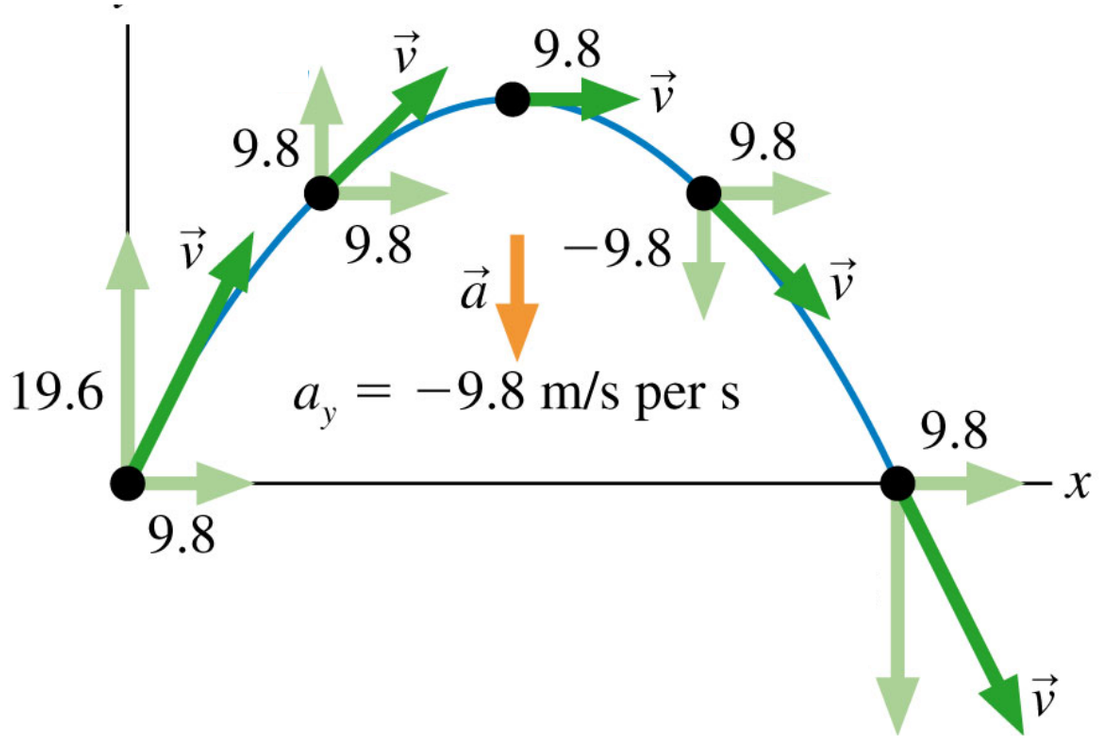
Fun Physics Fact of the Day

An incandescent lightbulb produces light by heating the filament to such a high temperature that it glows. They waste 95% of their energy as heat.

LEDs are semiconductor devices that produce light without needing to heat up (actually they run best when cool). They are 80 - 90% more efficient than incandescents.

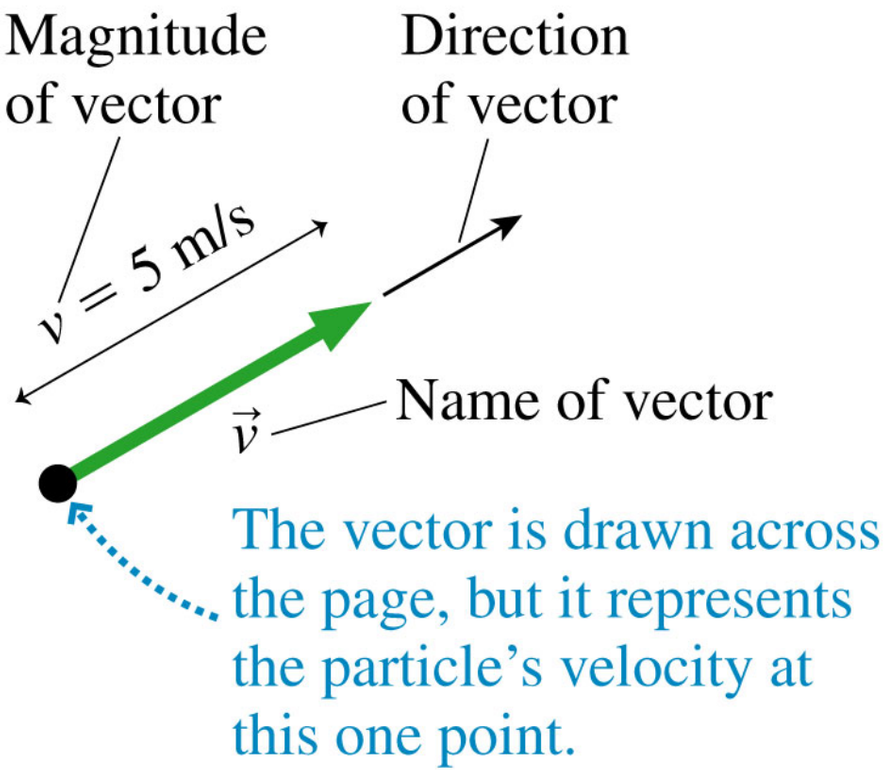



$\vec{v}$
9.8
$\vec{v}$
9.8
9.8
$\vec{v}$
9.8
−9.8
$\vec{a}$
$\vec{v}$
19.6
$a_y = -9.8$ m/s per s
9.8
9.8
x
$\vec{v}$

Vectors

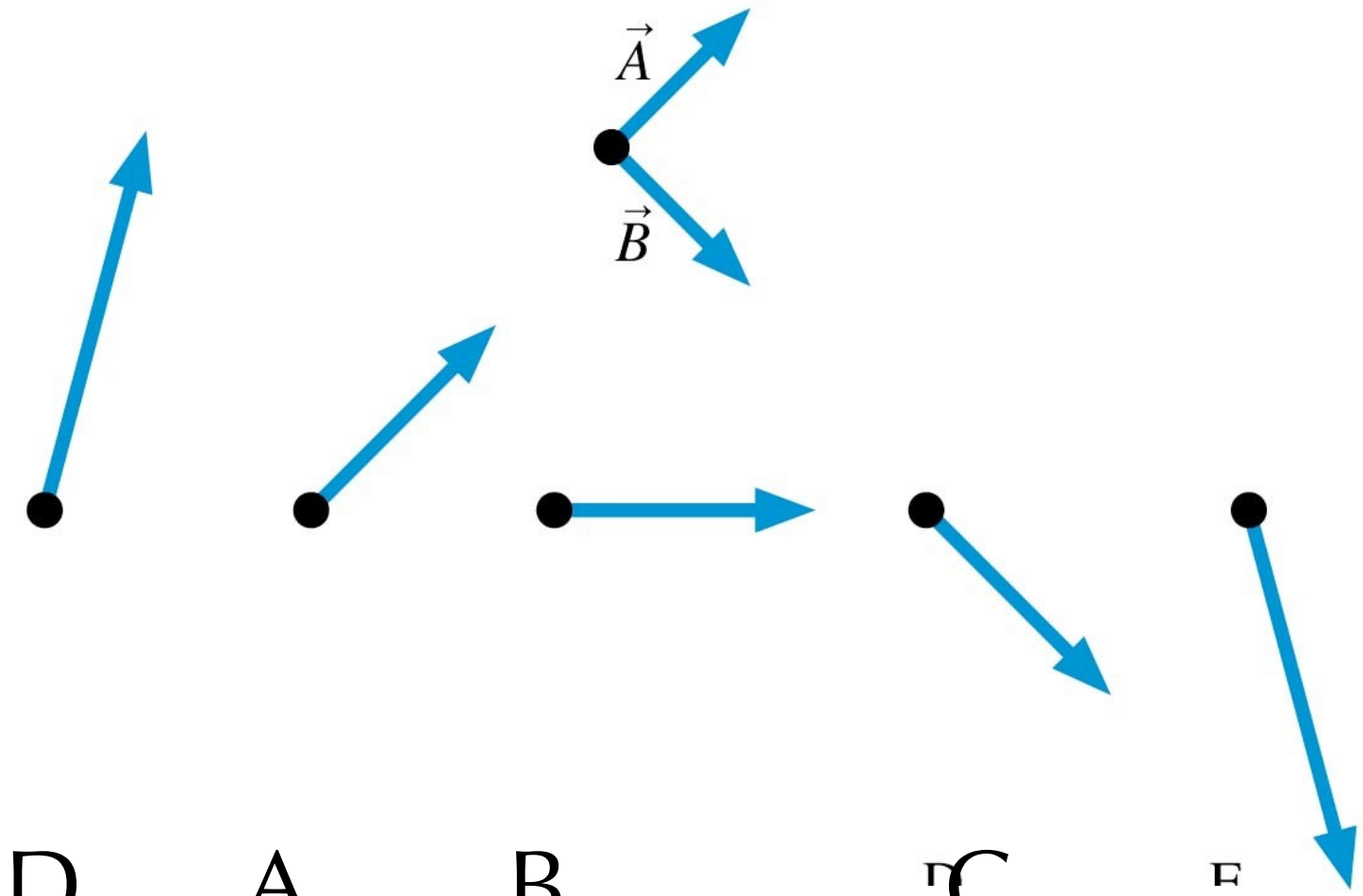
Magnitude

Direction



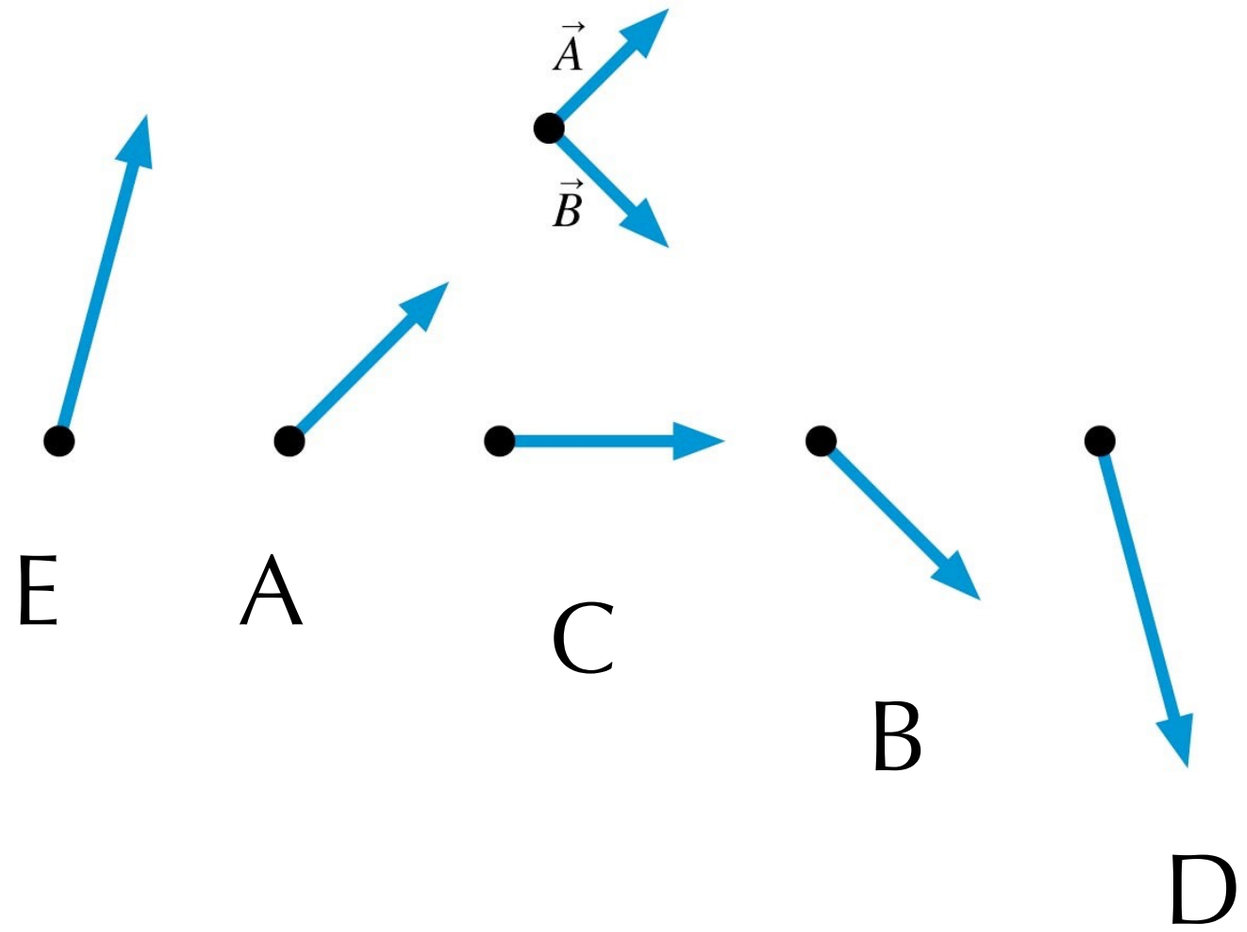
Question #19

Which of the vectors represents $\vec{A} + \vec{B}$

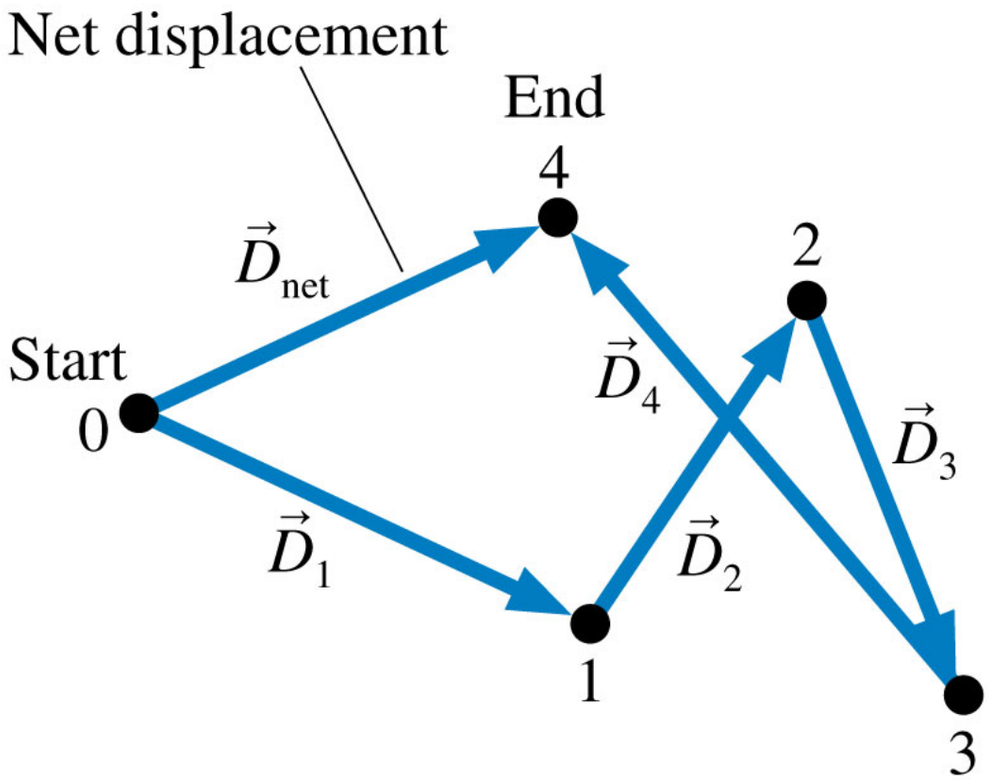


Question #20

Which vector represents $2\vec{A} - \vec{B}$



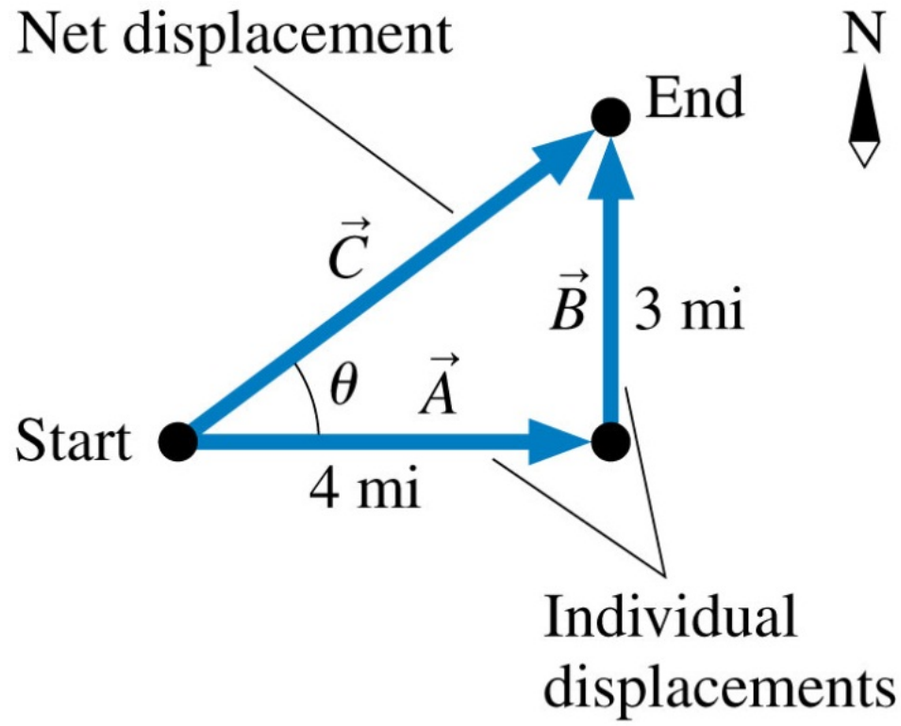
Addition of multiple vectors



$$\vec{D}_{\text{net}} = \vec{D}_1 + \vec{D}_2 + \vec{D}_3 + \vec{D}_4$$

Vector Addition

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



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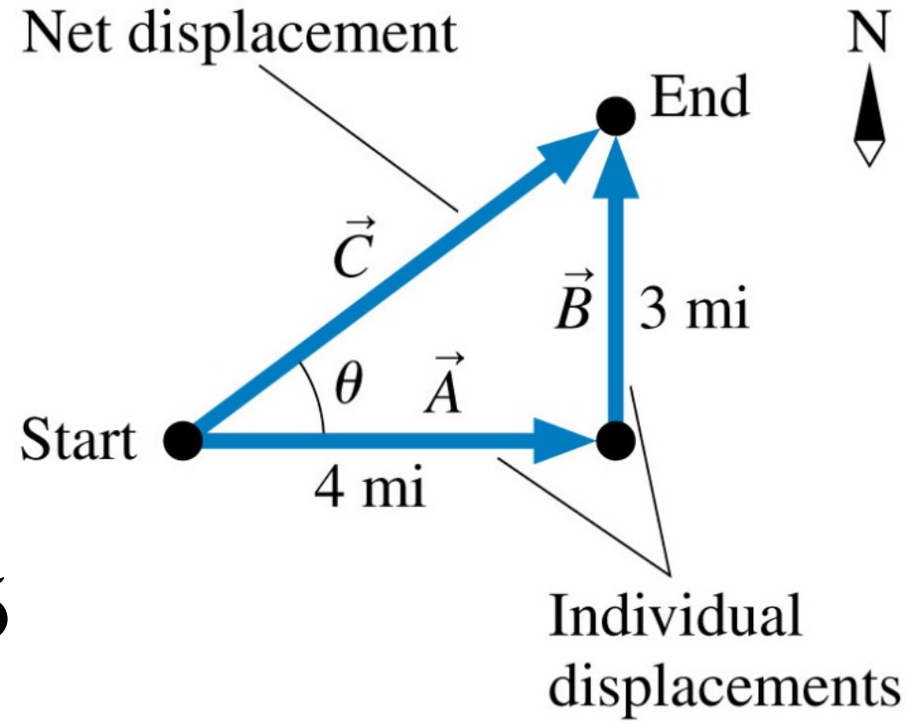

$$C = \sqrt{A^2 + B^2} = \sqrt{3^2 + 4^2} = 5$$

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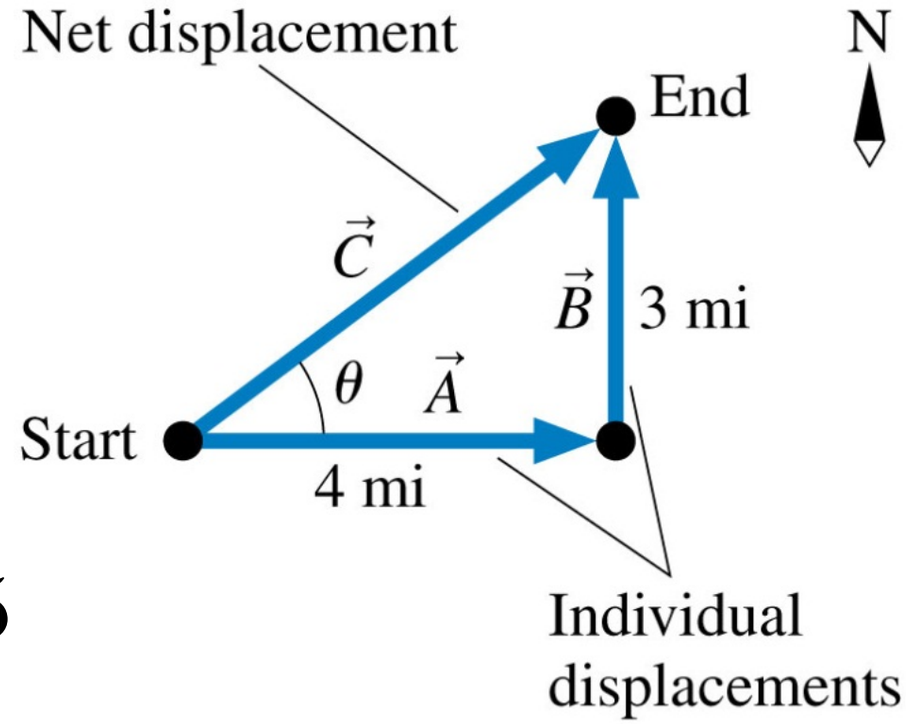

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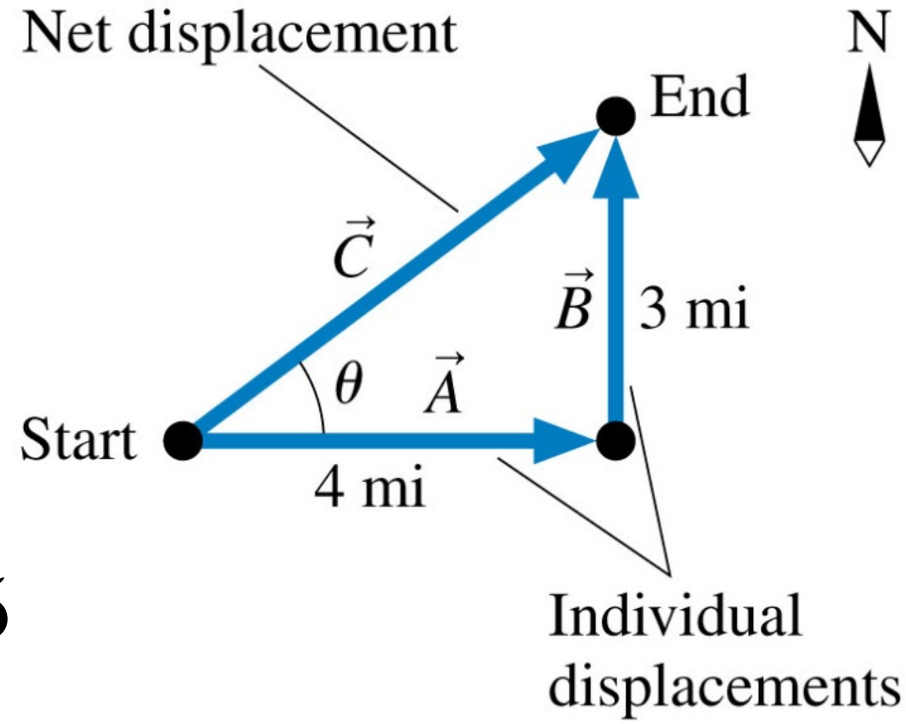

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$$\vec{C} = \vec{A} + \vec{B} = (5 \text{ mi}, 37^\circ \text{ north of east})$$

Addition of vectors (more challenging)

A bird flies 100 m due east from a tree, then 200 m northwest (45 degrees north of west). What is the bird's displacement vector?

Describe to your neighbor how you would attack this problem! Draw a picture, describe the math, but don't actually do the math.

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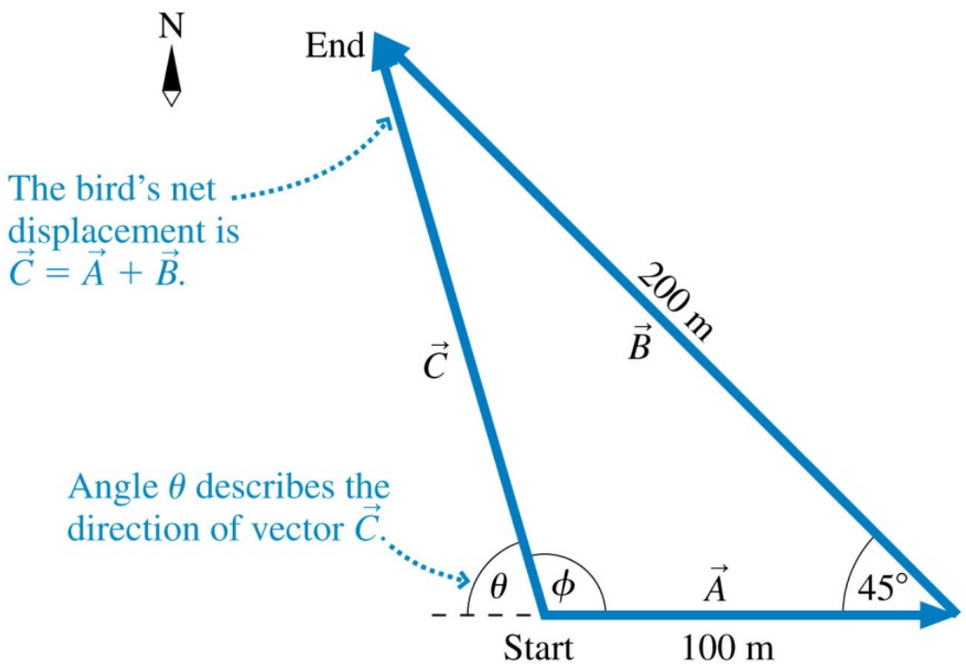

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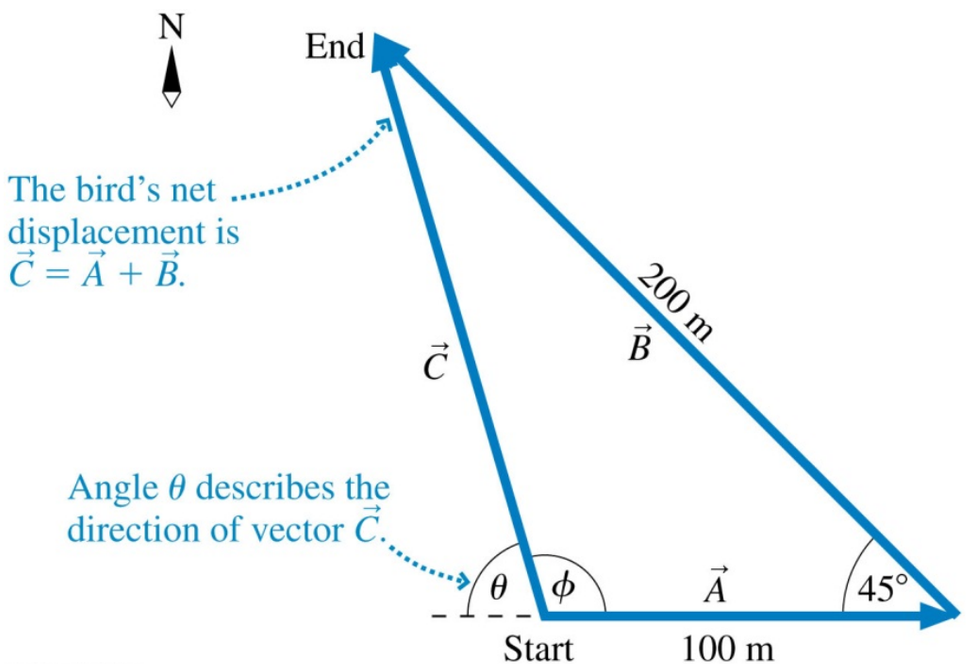

$$C^2 = A^2 + B^2 - 2AB\cos 45^\circ$$

$$= 21,720$$

$$C = \sqrt{21,720} = 147 \text{ m}$$

$$B^2 = A^2 + C^2 - 2AC\cos\phi$$

$$\phi = \cos^{-1}\left[\frac{A^2 + C^2 - B^2}{2AC}\right] = 106^\circ$$

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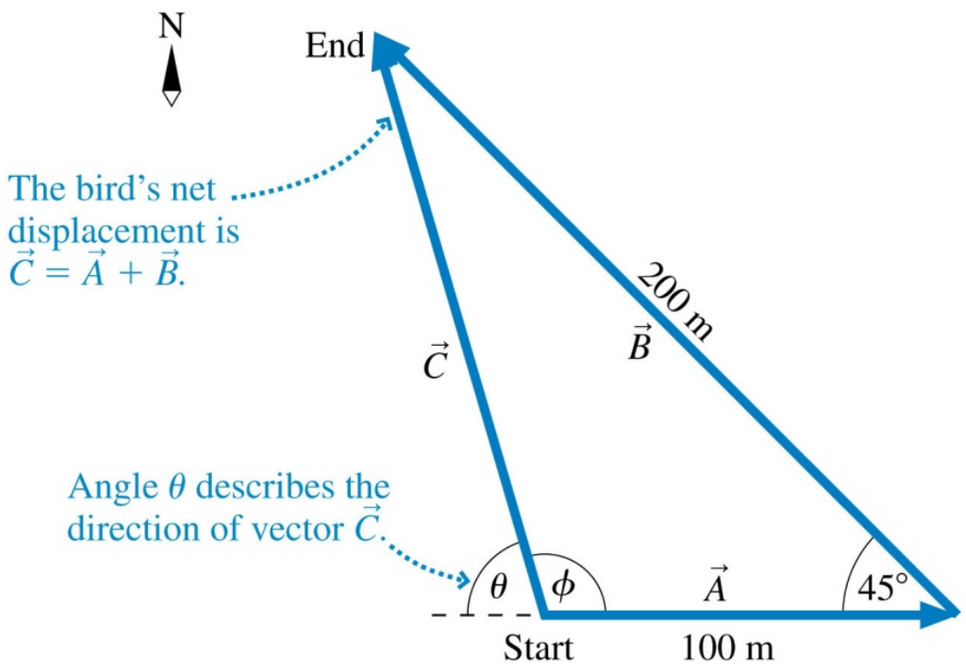
Yuck!!



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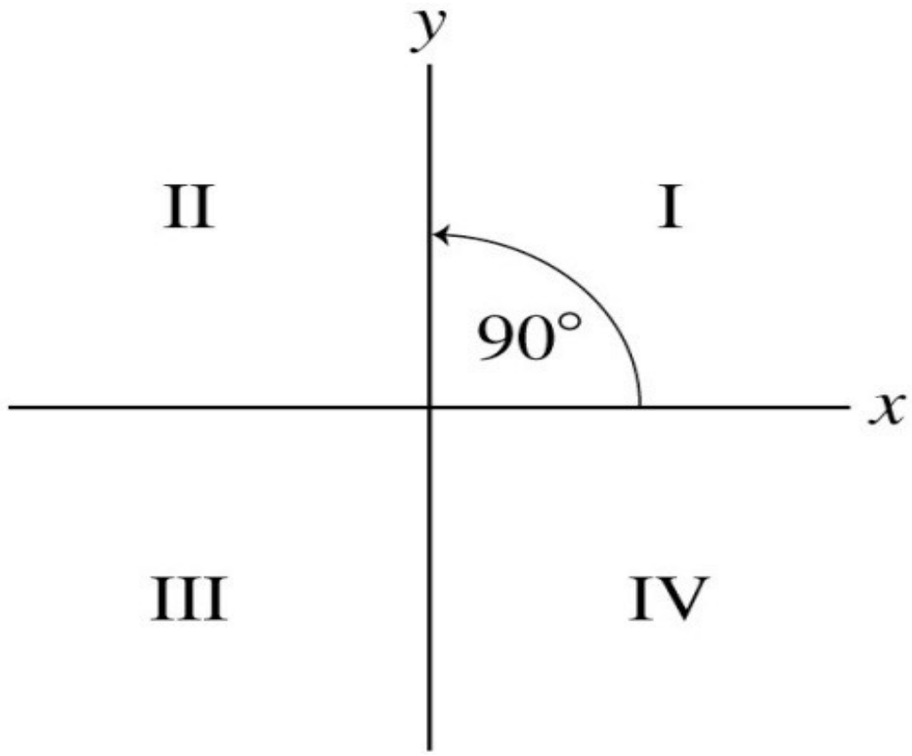
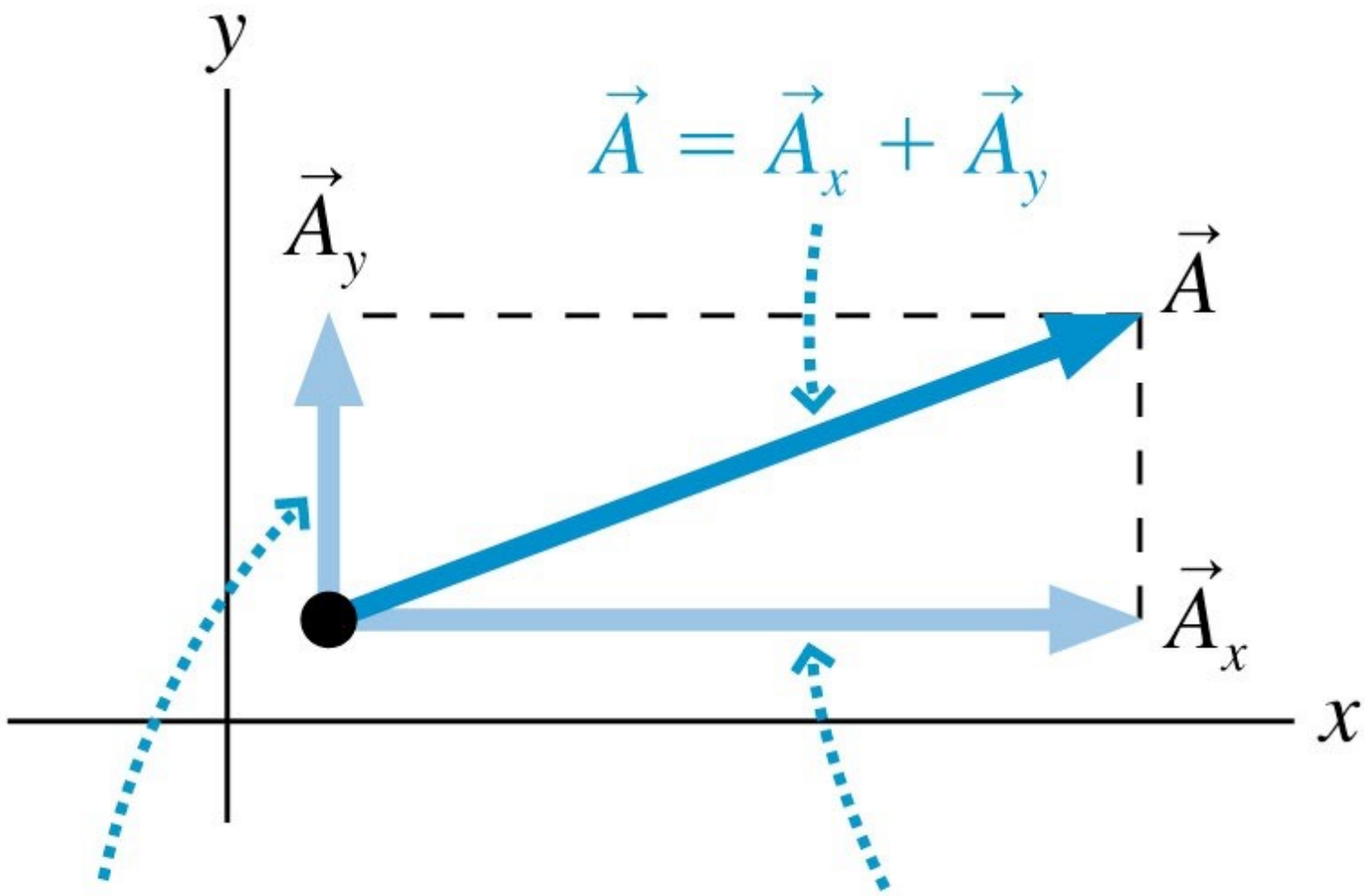
Coordinate Systems and Vector Components

- You are free to choose:
  - Where to place the origin, and
  - How to orient the axes.

The navigator had better know which way to go, and how far, if she and the crew are to make landfall at the expected location.



Component Vectors

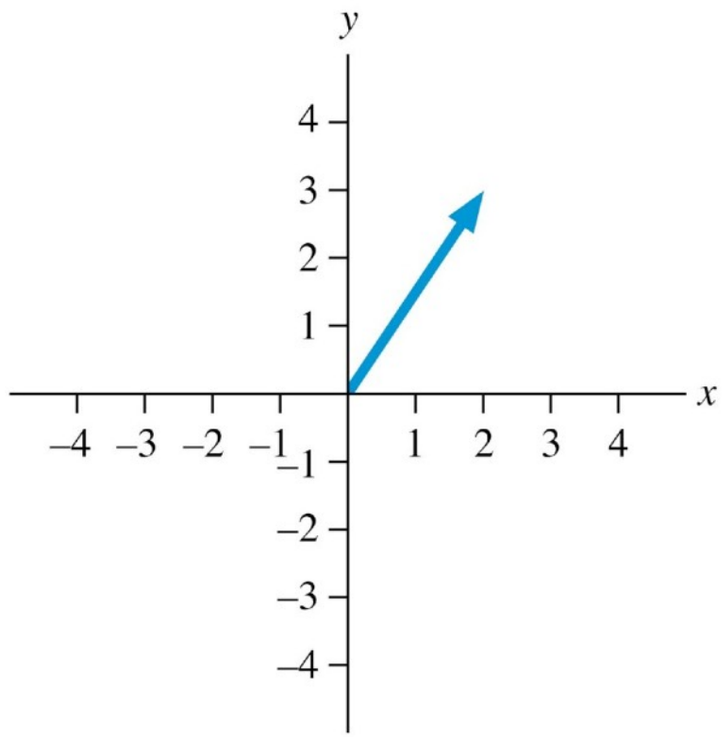


$$\vec{A} = \vec{A}_x + \vec{A}_y$$

Question #21

What are the x- and y- components of this vector?

a) (2,3)
b) (3,2)
c) (-3,2)
d) (2,-3)
e) (-3,-2)



Question #21

What are the x- and y- components of this vector?

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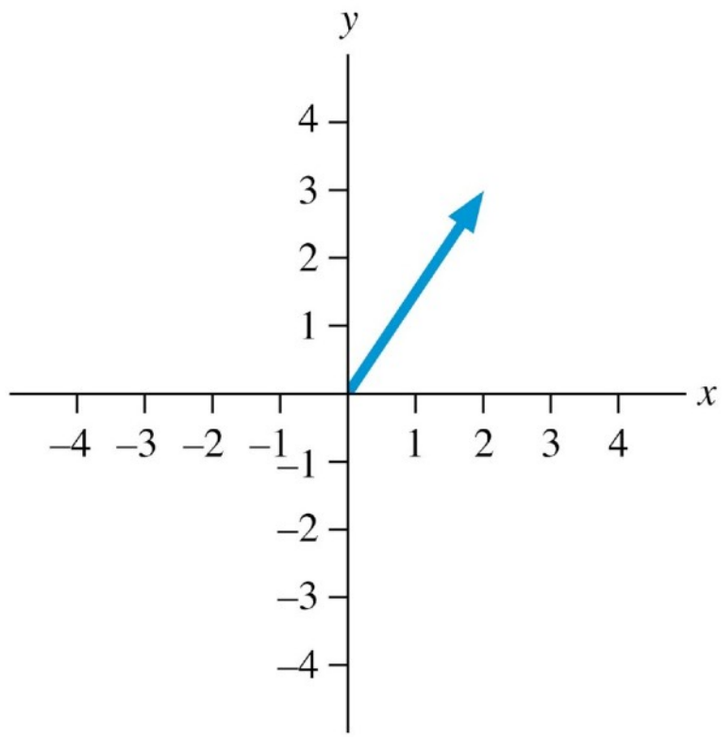
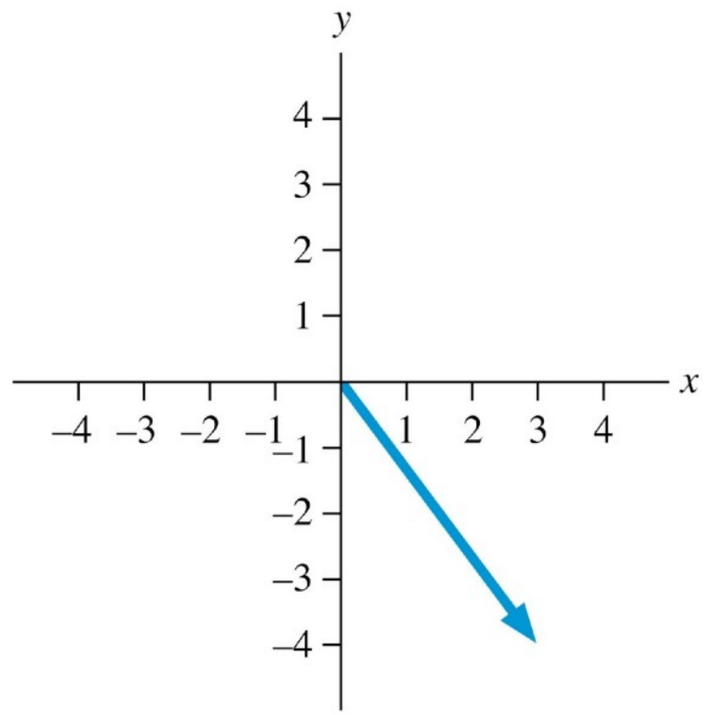


Question #22

What are the x- and y- components of this vector?

a) (3,4)
b) (4,3)
c) (3,-4)
d) (4,-3)
e) (-3,4)



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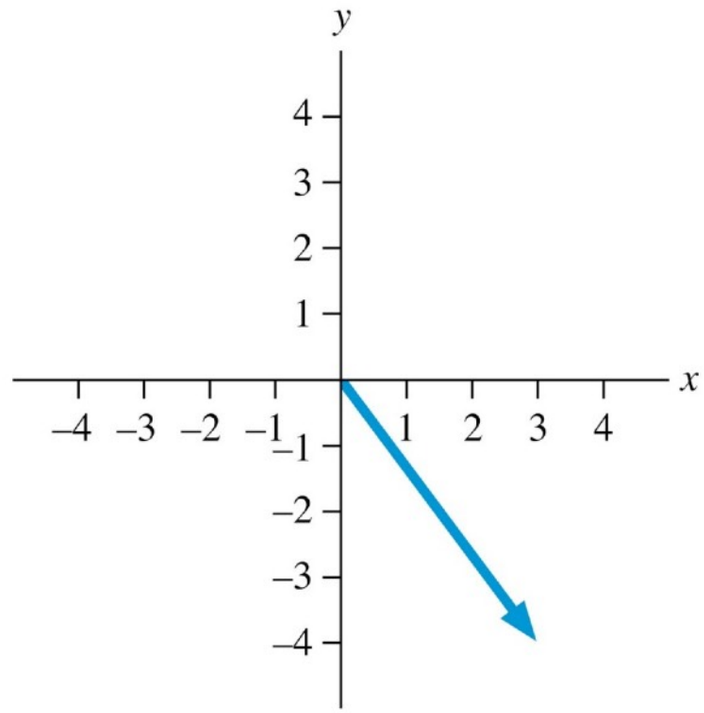
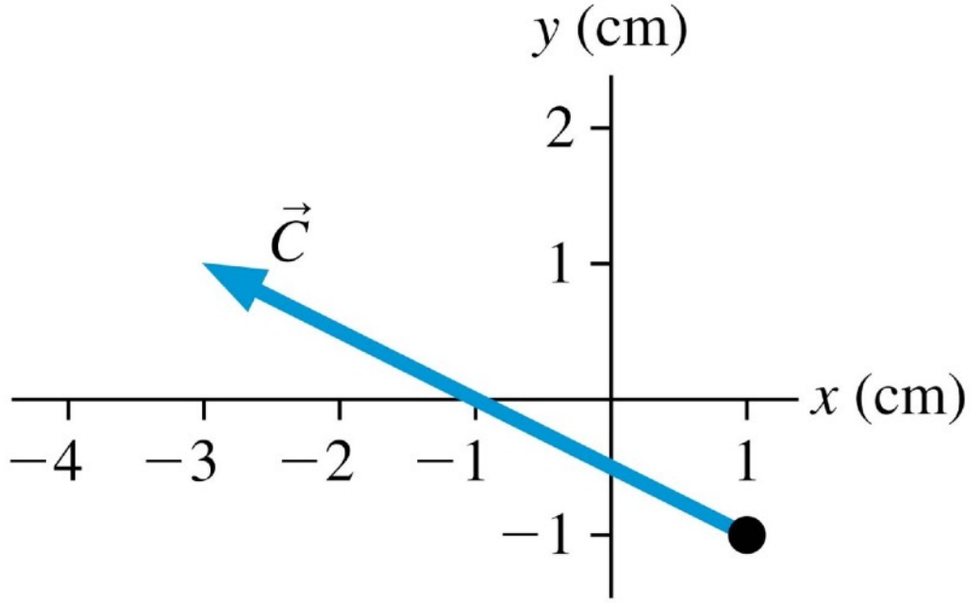


Question #23

What are the x- and y- components of this vector?

a) (1,-3)
b) (-3,1)
c) (1,-1)
d) (2,-4)
e) (-4,2)



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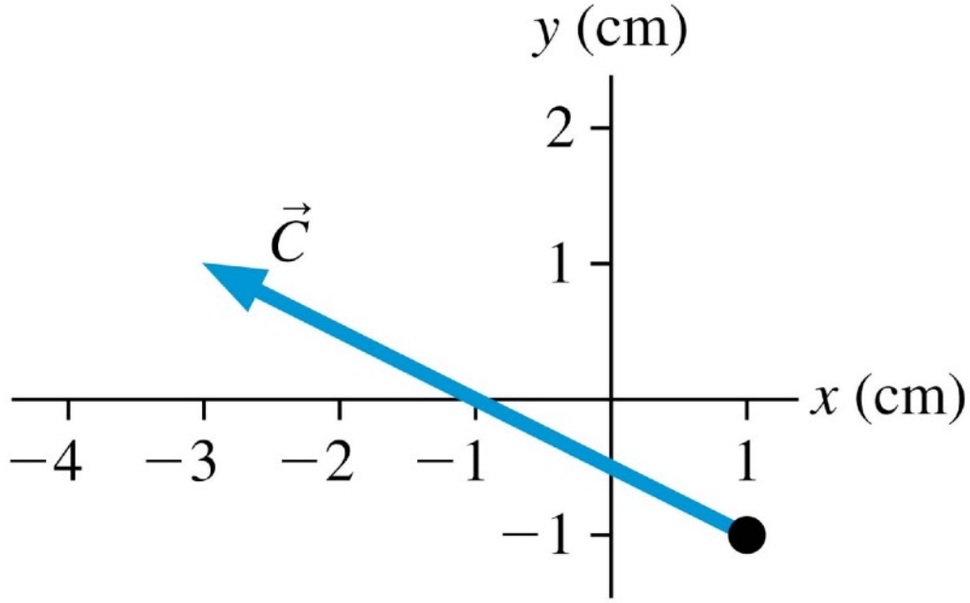
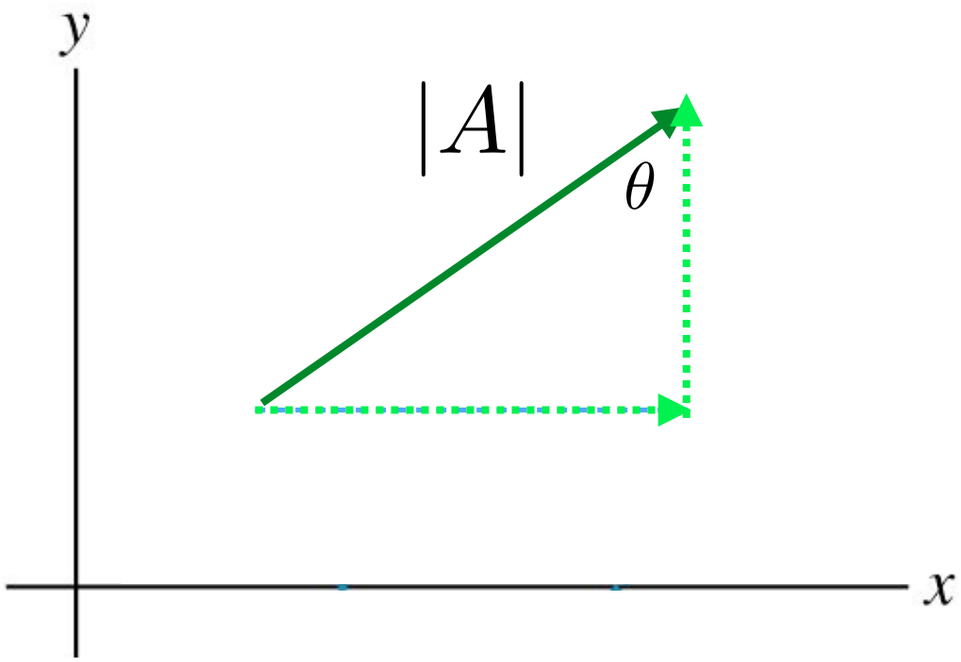
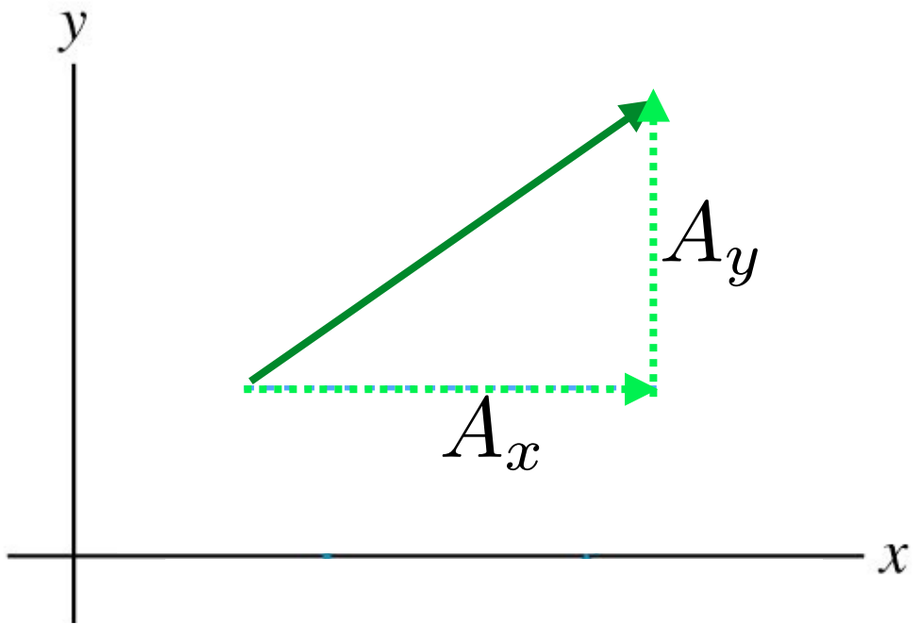


Moving between representations

$$\vec{A} = (|A|, \theta)$$



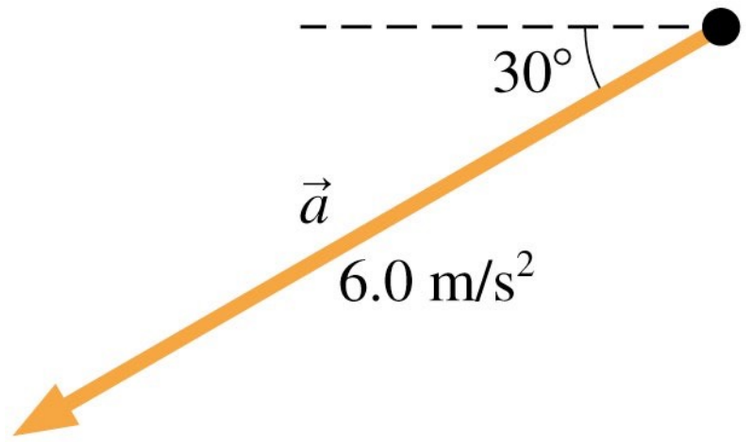
$$\vec{A} = (A_x, A_y)$$



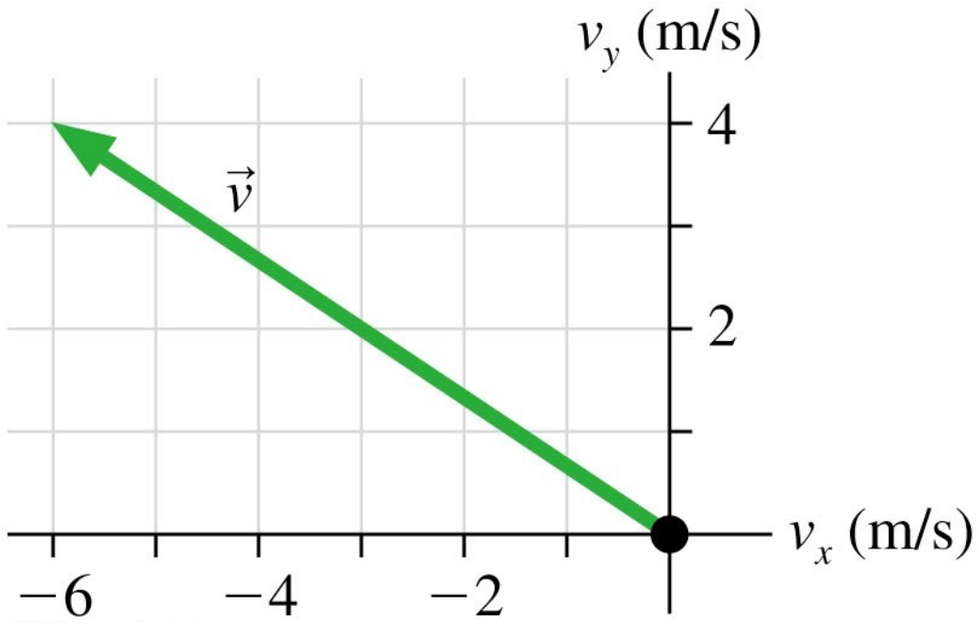
Question #24

Find the x- and y- components of the acceleration vector shown below.

a) (5.2,3) m/s^2
b) (-5.2,-3) m/s^2
c) (-3,-5.2) m/s^2
d) (-0.9,-5.9) m/s^2
e) (-5.9,-0.9) m/s^2



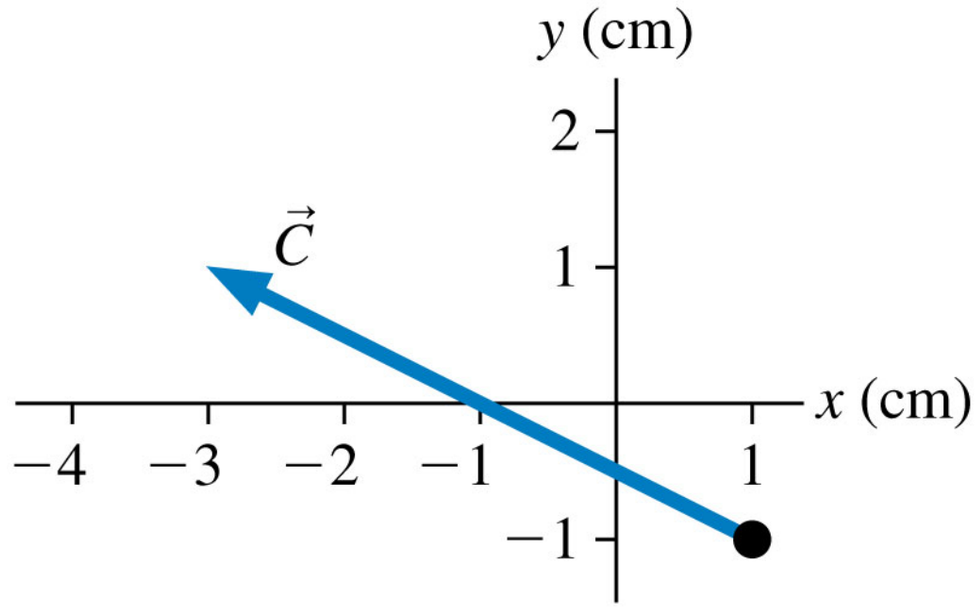
The figure below shows a car's velocity vector. Determine the car's speed and direction of motion.



Quiz

Vector $\vec{C}$ can be written as

a) $-3\hat{i} + \hat{j}$
b) $-4\hat{i} + 2\hat{j}$
c) $\hat{i} - 3\hat{j}$
d) $2\hat{i} - 4\hat{j}$
e) $\hat{i} - \hat{j}$



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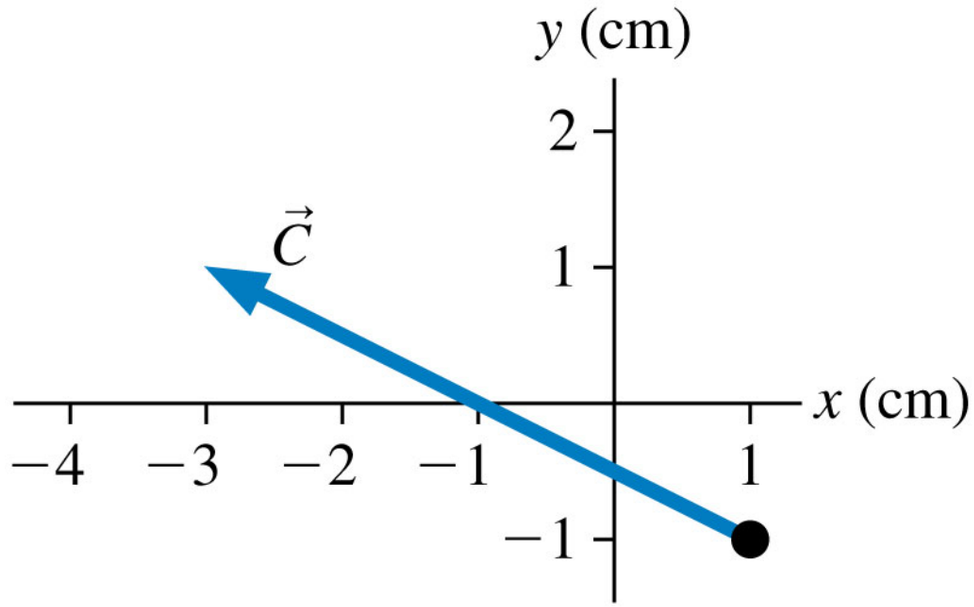

Quiz

A rabbit, escaping a fox, runs 40.0 degrees north of west at 10.0 m/s. A coordinate system is established with the positive x-axis to the east and the positive y-axis to the north. Write the rabbit's velocity using unit vectors.

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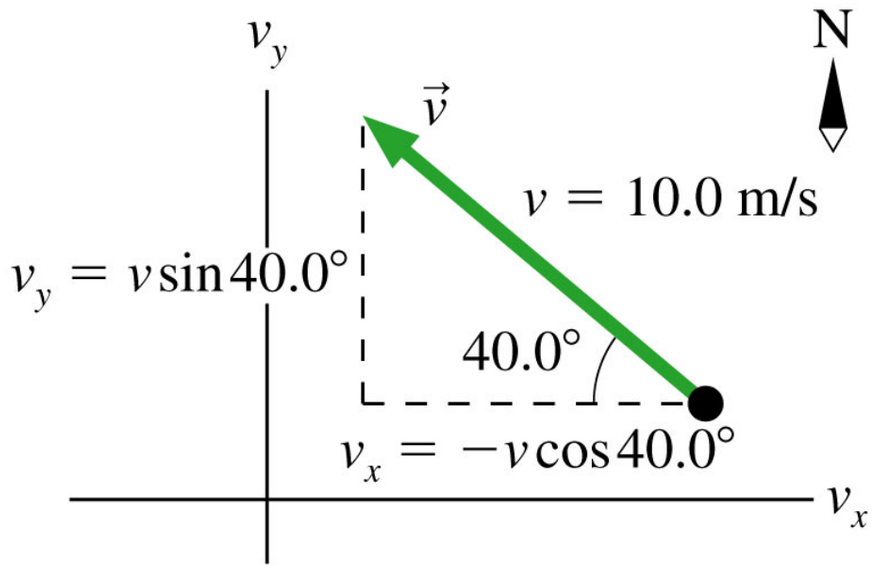

Adding vectors (the easy way)

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

$$\vec{R} = \vec{P} - \vec{Q}$$

$$D_{\mathrm{x}} = A_{\mathrm{x}} + B_{\mathrm{x}} + C_{\mathrm{x}}$$

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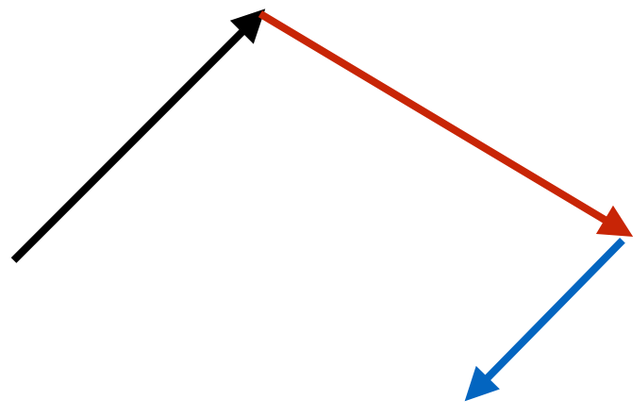

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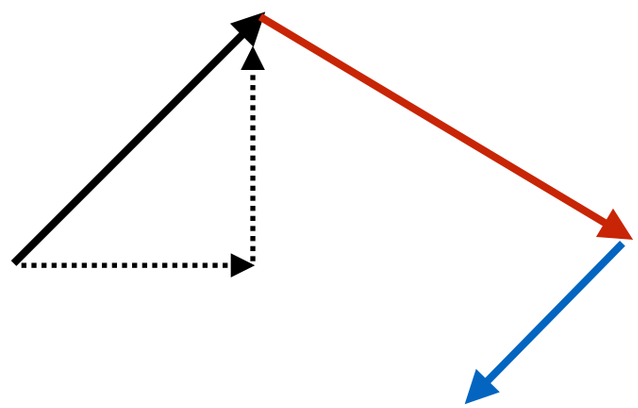

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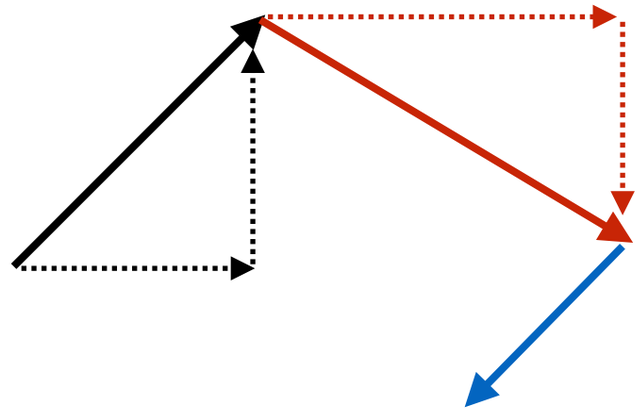

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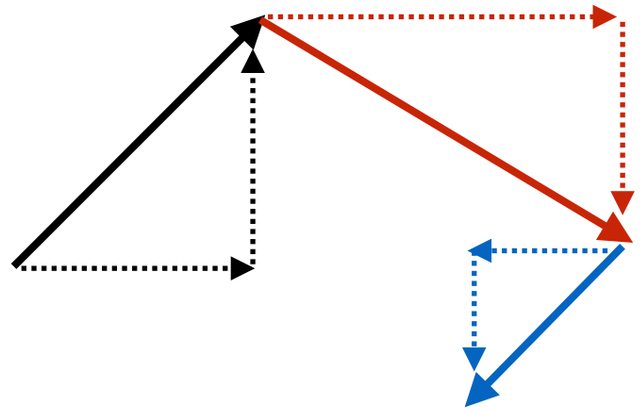

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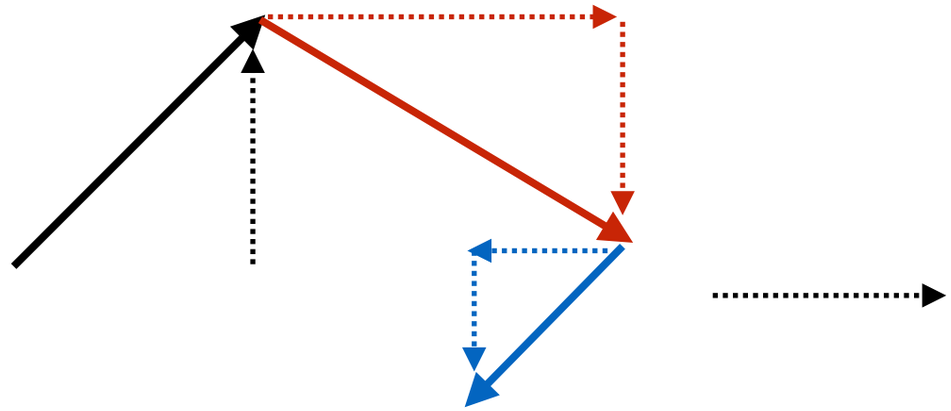

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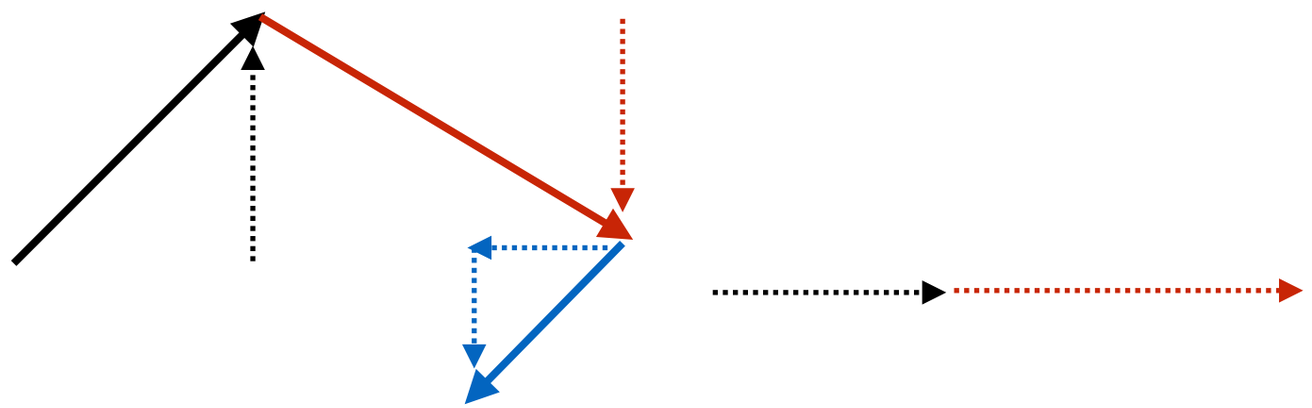

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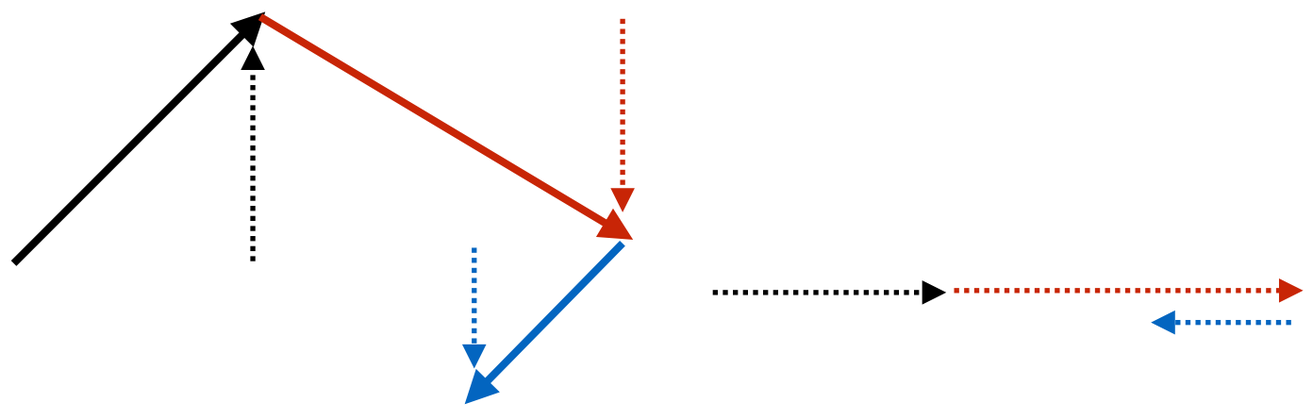

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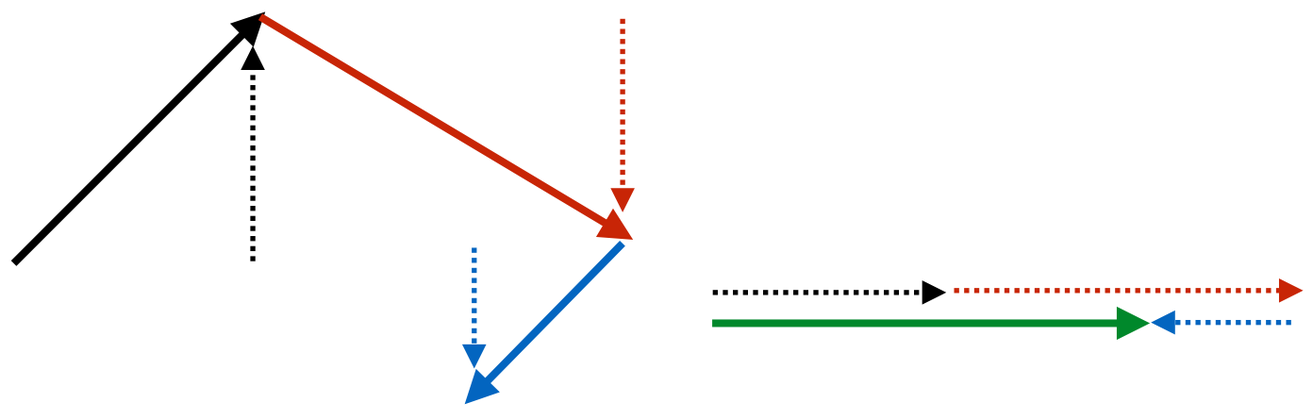

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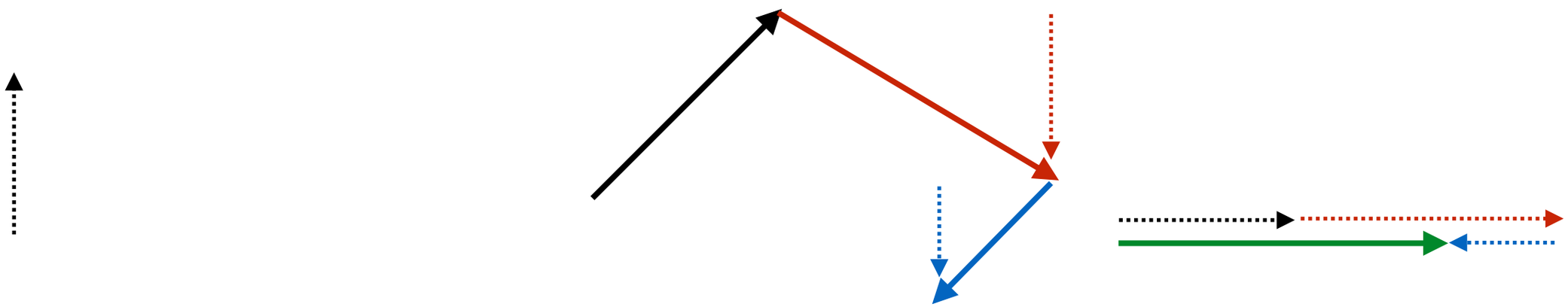

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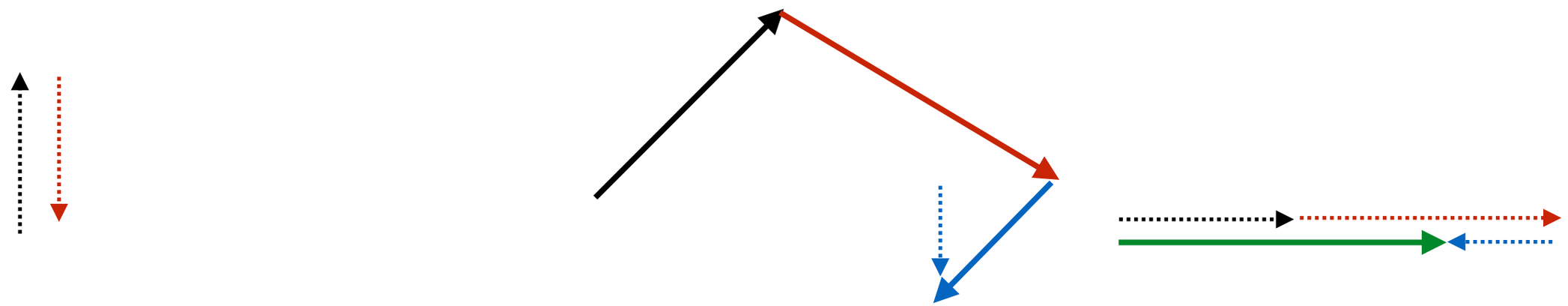

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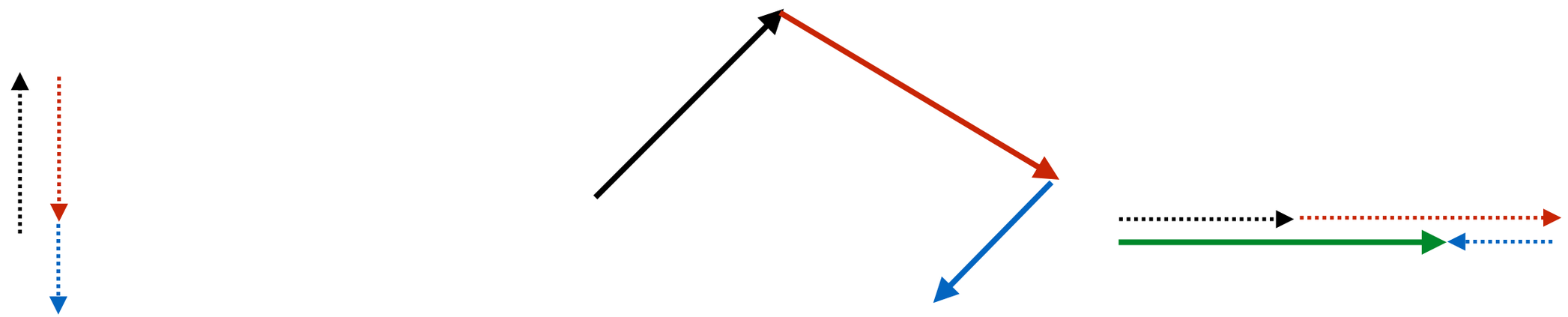

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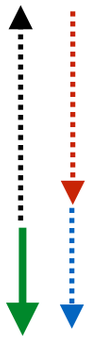

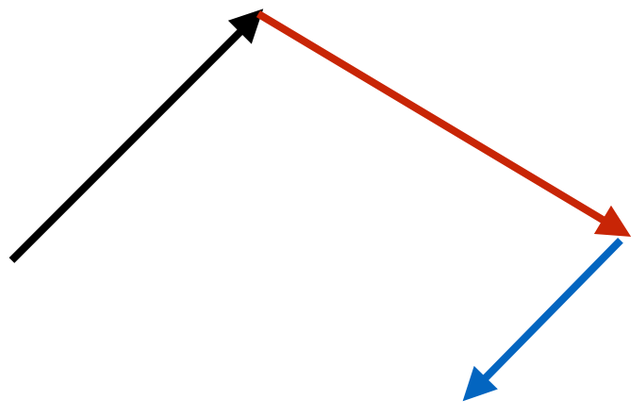

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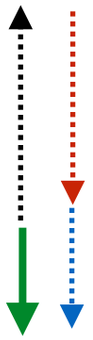

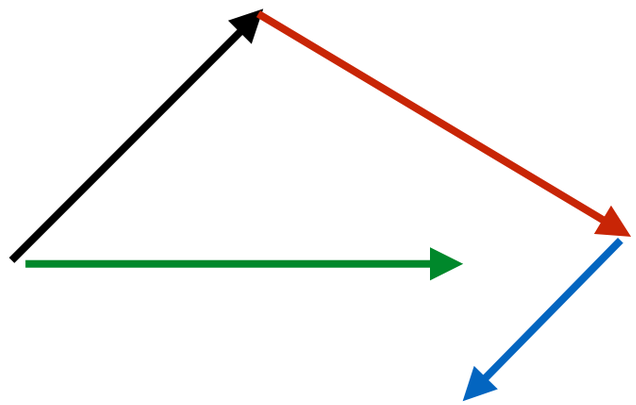

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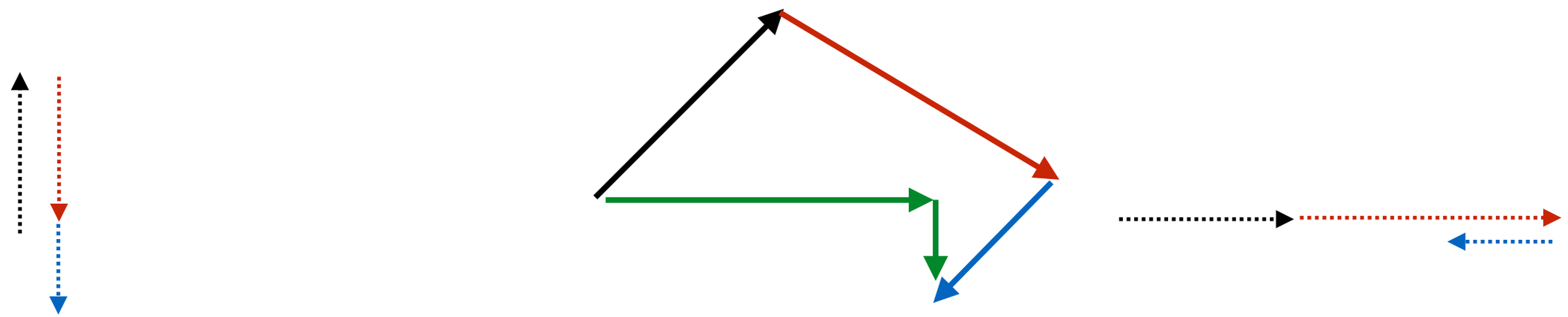

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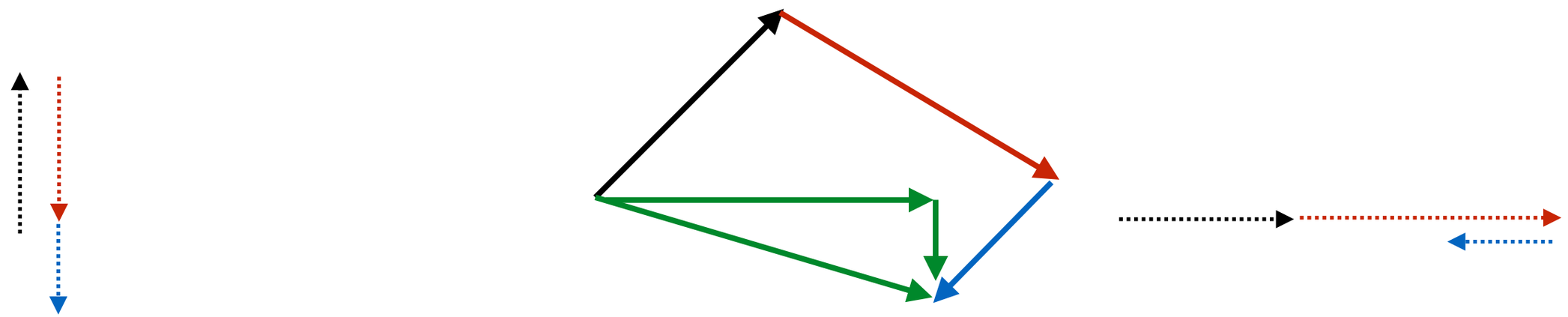
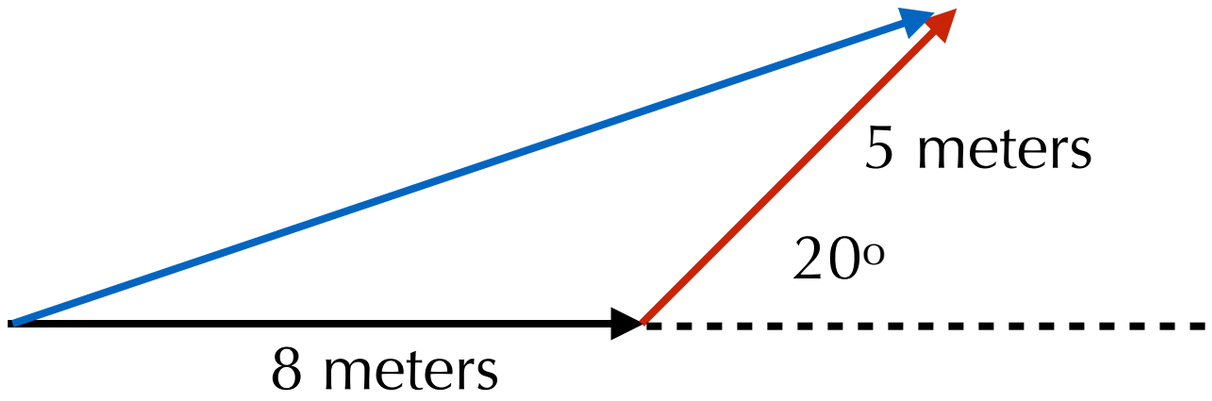
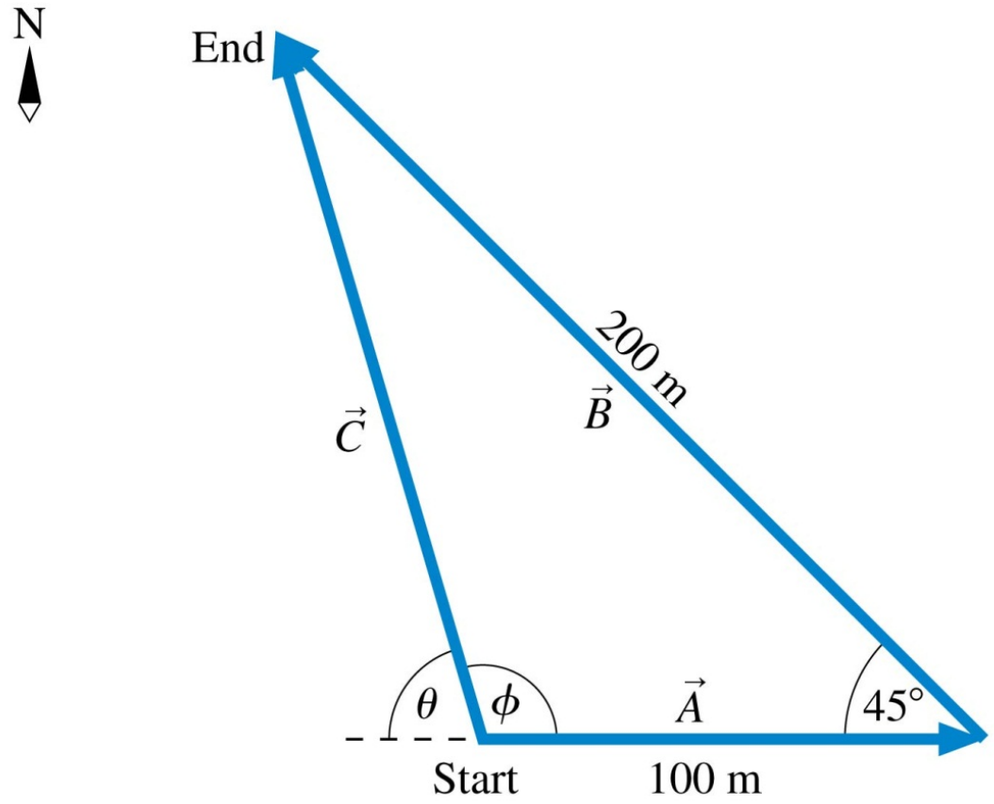


Bob walks due East for 8 meters, and then walks for 5 meters in a direction 20 degrees North of East. What is his net displacement vector in component form and polar form?

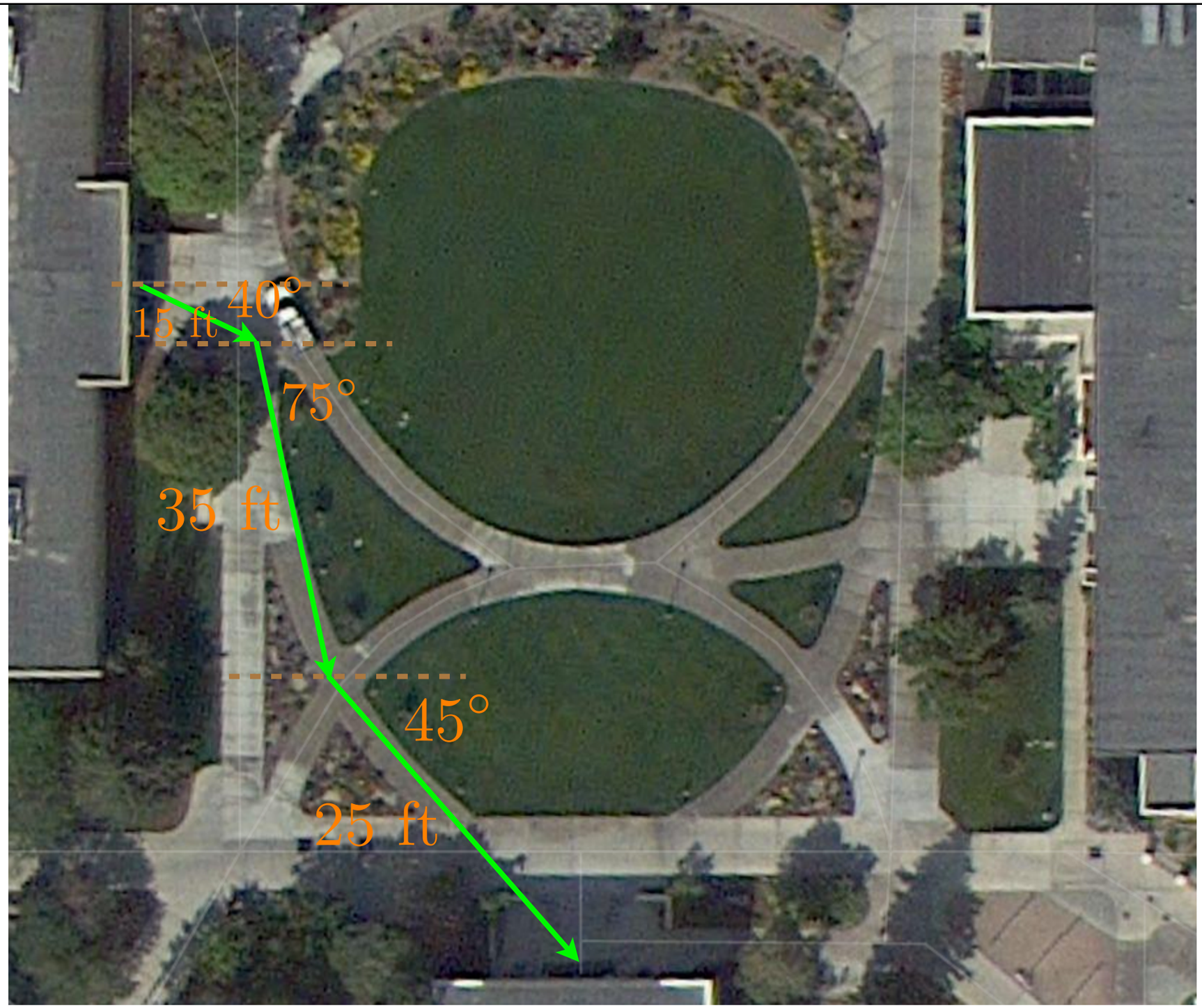


Try this one again using unit vectors

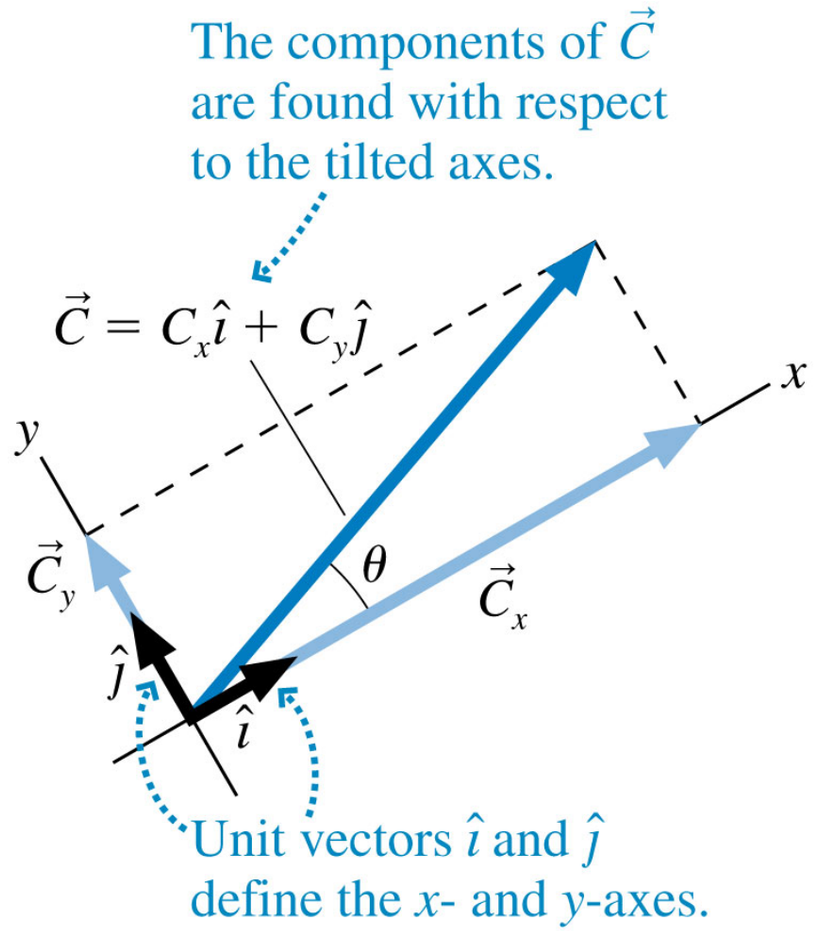
A bird flies 100 m due east from a tree, then 200 m northwest (45 degrees north of west). What is the bird's net displacement (use unit vectors this time).



You want to measure the distance (as the crow flies) from the Romney to the Library, but can't walk in a straight line from one building to the next. You decide to walk the path shown. Can you find the distance?



Tilted Axes


The components of $\vec{C}$ are found with respect to the tilted axes.
$\vec{C} = C_x\hat{\imath} + C_y\hat{\jmath}$
x
y
$\vec{C}_y$
θ
$\vec{C}_x$
$\hat{\jmath}$
$\hat{\imath}$
Unit vectors $\hat{\imath}$ and $\hat{\jmath}$ define the x- and y-axes.

Question #25

You apply a horizontal force of 10 N to a box on an incline. What are the components of the force perpendicular and parallel to the incline?

a) (8.7,-5) N
b) (5,8.7) N
c) (1.5,-9.8) N
d) (-8.7,-5) N
e) (-5,-8.7) N