

# Vectors Review



Representing and using vectors

# Vectors


- What are vector quantities?
  - Physical quantities that have both numerical and directional properties
  - A ***vector quantity*** is completely described by a number with appropriate units plus a direction.
  - It is denoted by an arrow:  $\vec{r}$



## Clicker Quiz

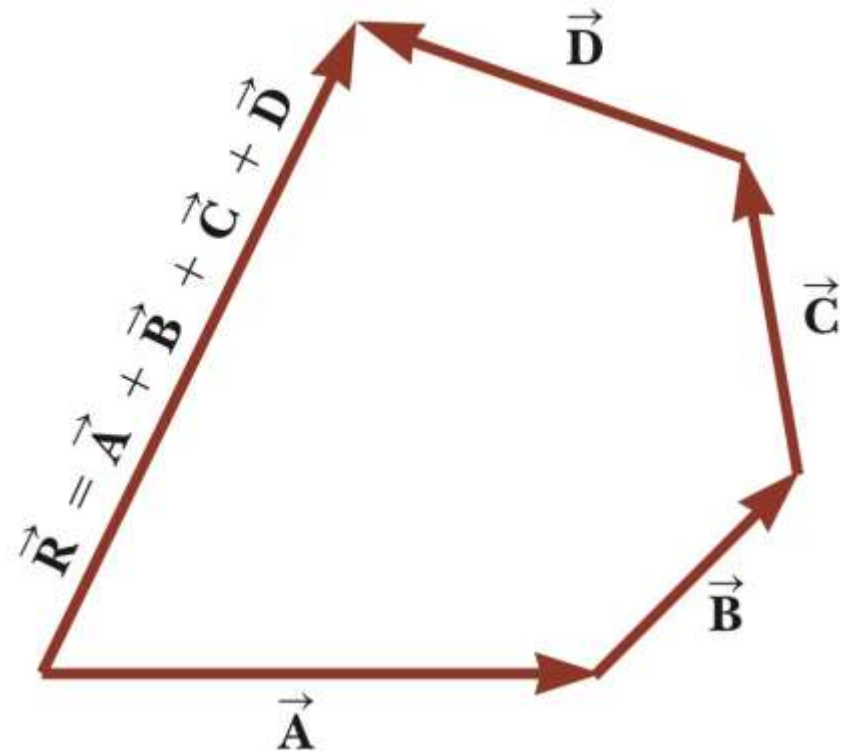
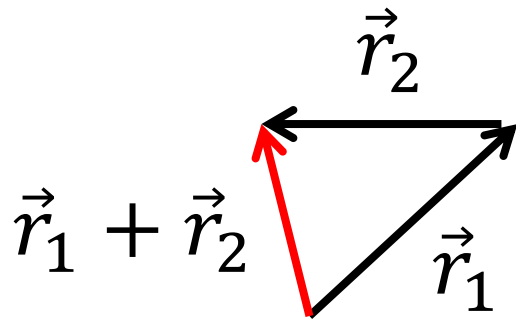
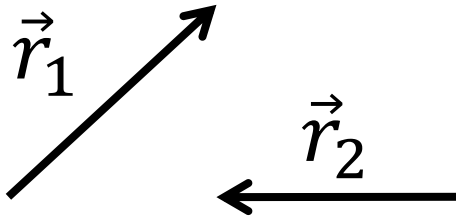
- Which of the following are vector quantities and which are scalar quantities: a) your age, b) velocity, c) acceleration, d) speed, e) your mass
- 
- A. All of them are vectors.
  - B. All of them are scalars.
  - C. a, b, and c are vectors; d, e are scalars.
  - D. a, d, e are vectors; b, c are scalars.
  - E. a, d, e are scalar, b, c are vectors.

## Clicker Quiz

- Which of the following are vector quantities and which are scalar quantities: a) your age, b) velocity, c) acceleration, d) speed, e) your mass
- 
- A. All of them are vectors.
  - B. All of them are scalars.
  - C. a, b, and c are vectors; d, e are scalars.
  - D. a, d, e are vectors; b, c are scalars.
  -  E. a, d, e are scalar, b, c are vectors.

# Vectors

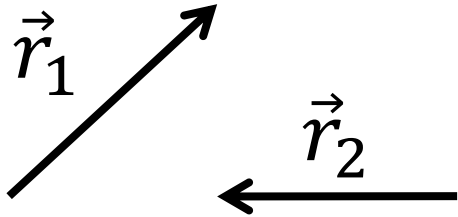
- Adding vectors:



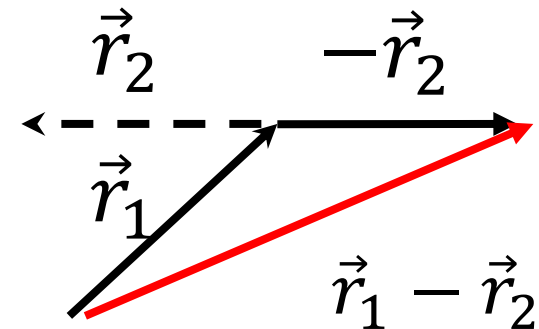
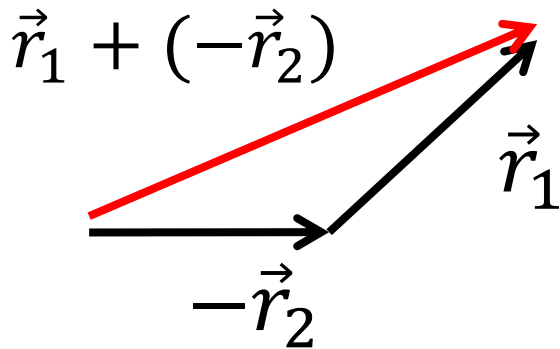
# Vectors

- Subtracting vectors:

$\vec{r}_1 - \vec{r}_2$  is the same as  $\vec{r}_1 + (-\vec{r}_2)$



$$\vec{r}_1 - \vec{r}_2 = \vec{r}_1 + (-\vec{r}_2)$$



## Clicker Quiz

- The figure below shows two vectors  $\vec{r}_1$  and  $\vec{r}_2$ .



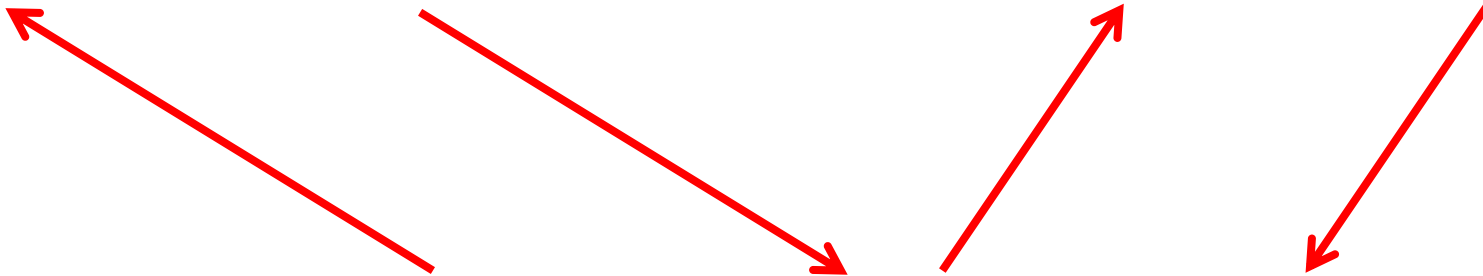
Which of the following vectors best shows the difference between the two vectors; that is:  $\Delta\vec{r} = \vec{r}_1 - \vec{r}_2$ .

A.

B.

C.

D.



## Clicker Quiz

- The figure below shows two vectors  $\vec{r}_1$  and  $\vec{r}_2$ .



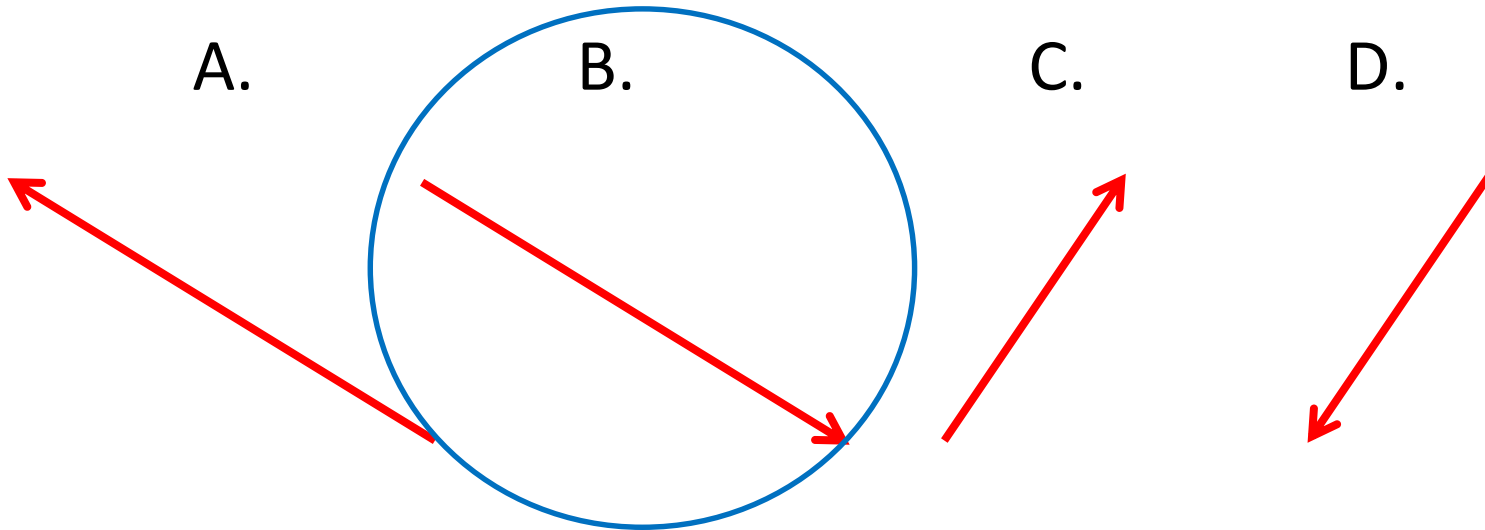
Which of the following vectors best shows the difference between the two vectors; that is:  $\Delta\vec{r} = \vec{r}_2 - \vec{r}_1$ .

A.

B.

C.

D.






## Clicker Quiz

- If vector  $\vec{A}$  is added to vector  $\vec{B}$ , which two of the following choices must be true for the resultant vector to be equal to zero?
  - i.  $\vec{A}$  and  $\vec{B}$  are parallel and in the same direction.
  - ii.  $\vec{A}$  and  $\vec{B}$  are parallel and in opposite direction.
  - iii.  $\vec{A}$  and  $\vec{B}$  have the same magnitude.
  - iv. Both statements i and iii
  - v. Both statements ii and iii

## Clicker Quiz

- If vector  $\vec{A}$  is added to vector  $\vec{B}$ , which two of the following choices must be true for the resultant vector to be equal to zero?
  - i.  $\vec{A}$  and  $\vec{B}$  are parallel and in the same direction.
  - ii.  $\vec{A}$  and  $\vec{B}$  are parallel and in opposite direction.
  - iii.  $\vec{A}$  and  $\vec{B}$  have the same magnitude.
  - iv. Both statements i and iii
  -  v. Both statements ii and iii

# Vectors

- Components of a vector:

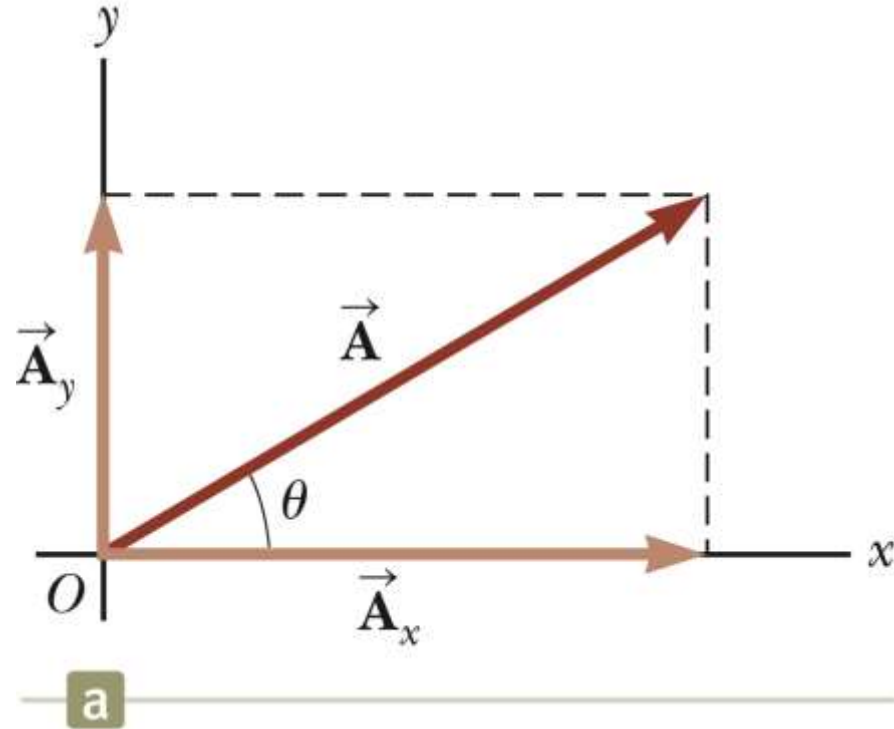
$$\vec{A} = \vec{A}_x + \vec{A}_y$$

$$A_x = A \cos \theta$$

$$A_y = A \sin \theta$$

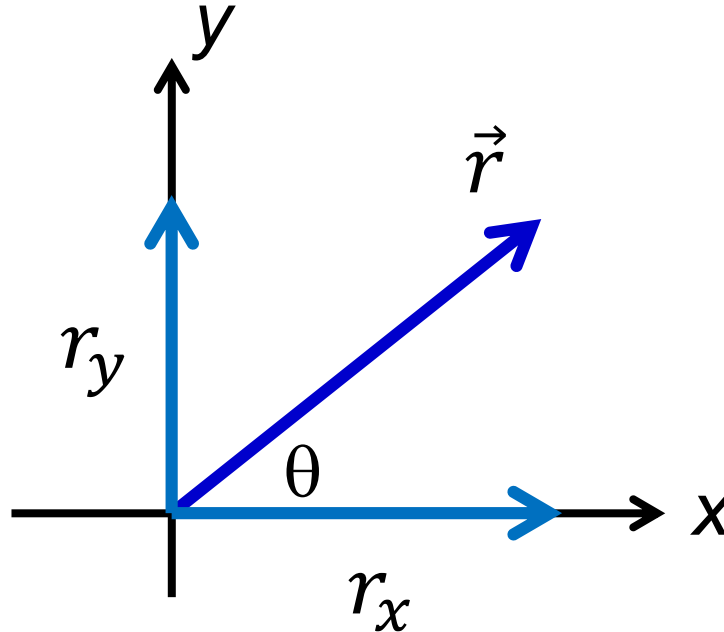
$$A = \sqrt{A_x^2 + A_y^2}$$

$$\theta = \tan^{-1} (A_y / A_x)$$



# Vectors

Vectors in 2D can be represented by two numbers:



1. Magnitude and directional angle

$$\vec{r} = \begin{cases} r \\ \theta \end{cases}$$

2. Two components

$$\vec{r} = \begin{cases} r_x \\ r_y \end{cases}$$

## Example

- John walks to the store using the following path: 0.500 west, 0.200 km north, and 0.300 km east. What is her total displacement? Give the magnitude and the direction.
  - Take north to be in the  $+y$  direction and east to be along  $+x$ .

## Example

- John walks to the store using the following path: 0.500 km west, 0.200 km north, and 0.300 km east. What is her total displacement? Give the magnitude and the direction.
  - Take north to be in the +y direction and east to be along +x.

$$\Delta r_x = -r_1 + r_3 = -0.200 \text{ km}$$

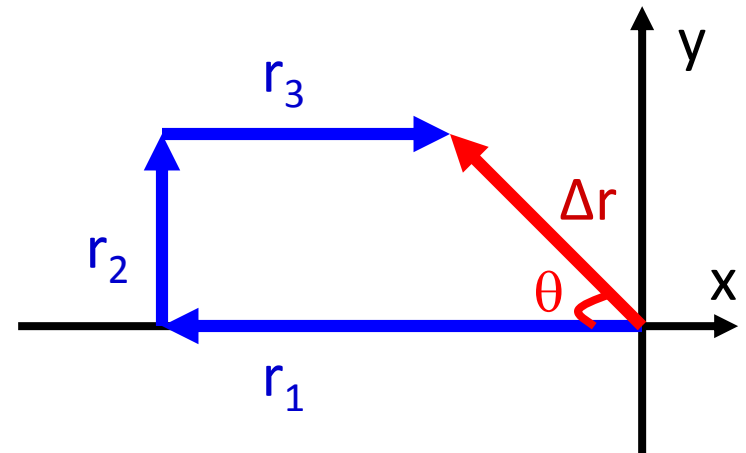
$$\Delta r_y = r_2 = 0.200 \text{ km}$$

$$\Delta r = \sqrt{(-0.200)^2 + (0.200)^2}$$

$$\Delta r = 0.283 \text{ km}$$

$$\tan\theta = \Delta r_y / \Delta r_x$$

$$\tan\theta = -1 \quad \theta = -45^\circ = 135^\circ$$

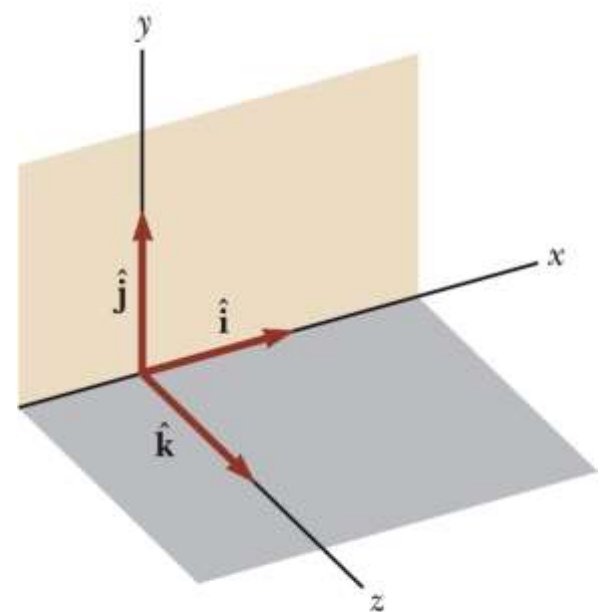


# Vectors

## Unit vectors

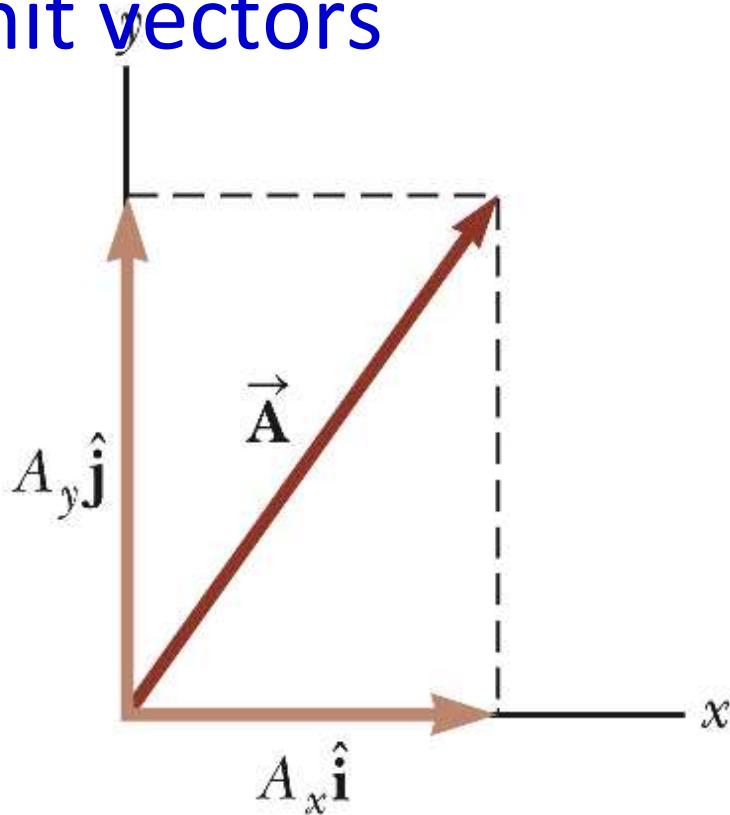
- A **unit vector** is a dimensionless vector with a magnitude of exactly 1.
- Unit vectors are used to specify a direction and have no other physical significance.
- The symbols  $\vec{i}$ ,  $\vec{j}$ , and  $\vec{k}$  represent unit vectors

$$|\hat{i}| = |\hat{j}| = |\hat{k}| = 1$$

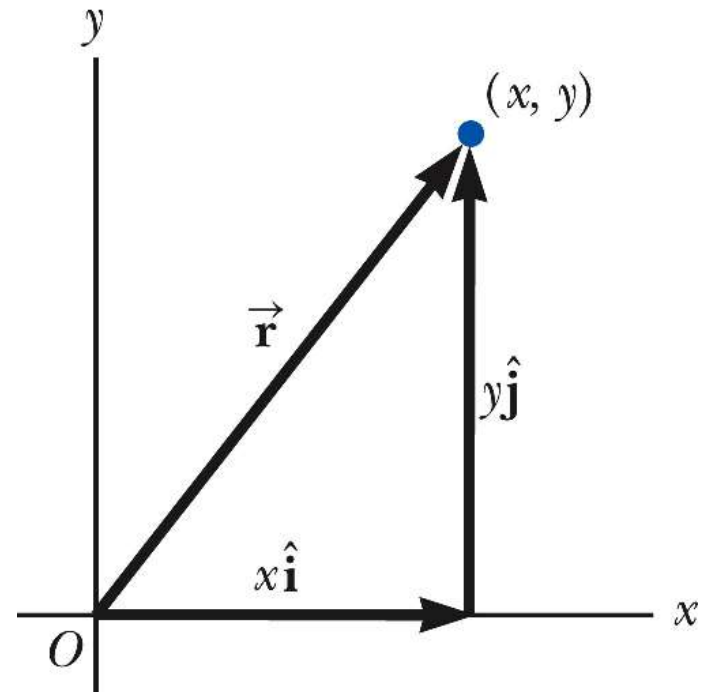


# Vectors

## Unit vectors



$$\vec{A} = A_x \hat{i} + A_y \hat{j}$$



$$\vec{r} = x \hat{i} + y \hat{j}$$



# Vectors

- Adding vectors:

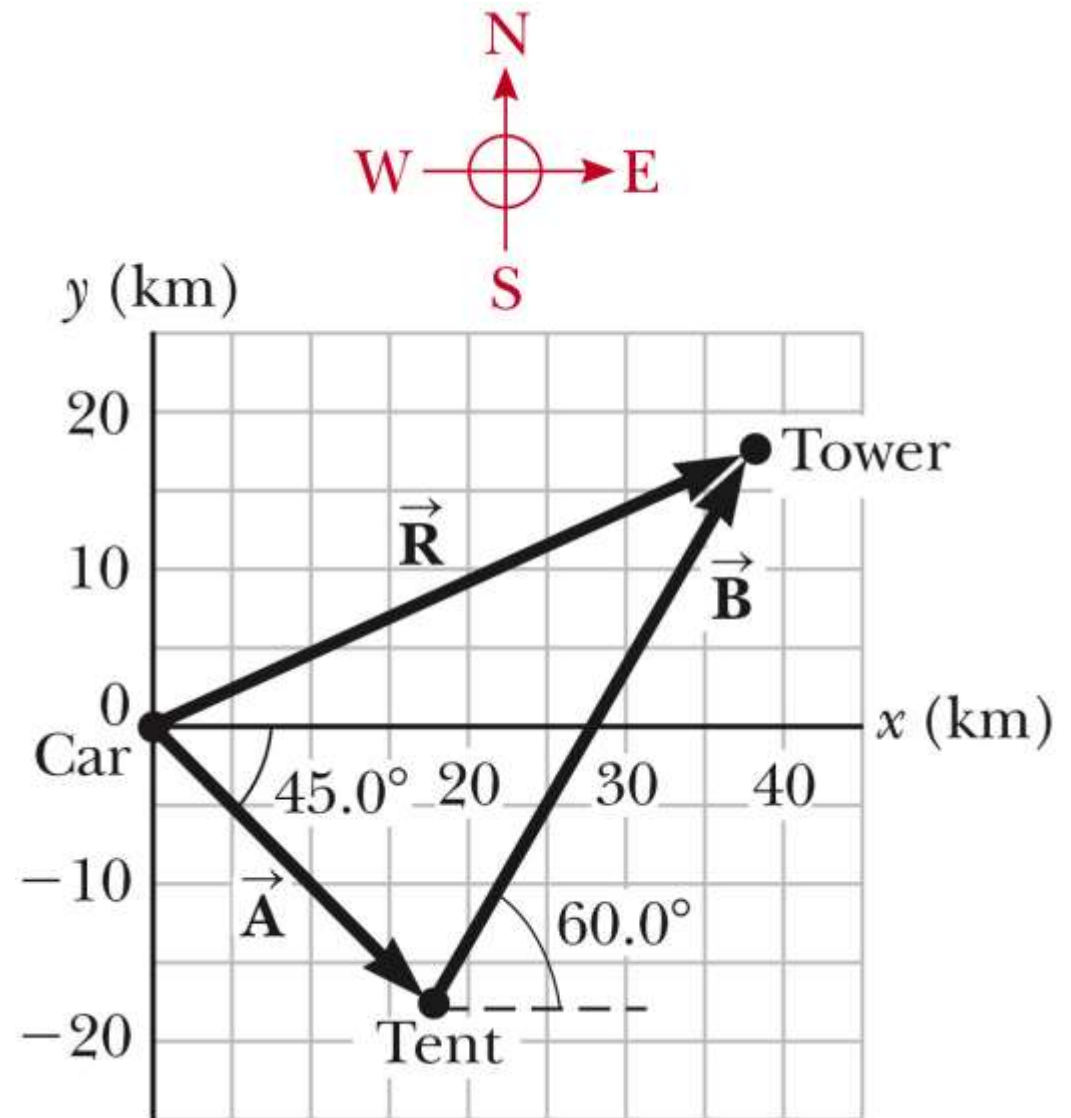
$$\vec{R} = \vec{A} + \vec{B} + \vec{C}$$

$$\vec{R} = (A_x + B_x + C_x)\hat{i} + (A_y + B_y + C_y)\hat{j} + (A_z + B_z + C_z)\hat{k}$$

## Example

- A hiker begins a trip by first walking 25.0 km southeast from her car. She stops and sets up her tent for the night. On the second day, she walks 40.0 km in a direction  $60.0^\circ$  north of east, at which point she discovers a forest ranger's tower. Estimate that the final position of the hiker
  - Take north to be in the +y direction and east to be along +x.

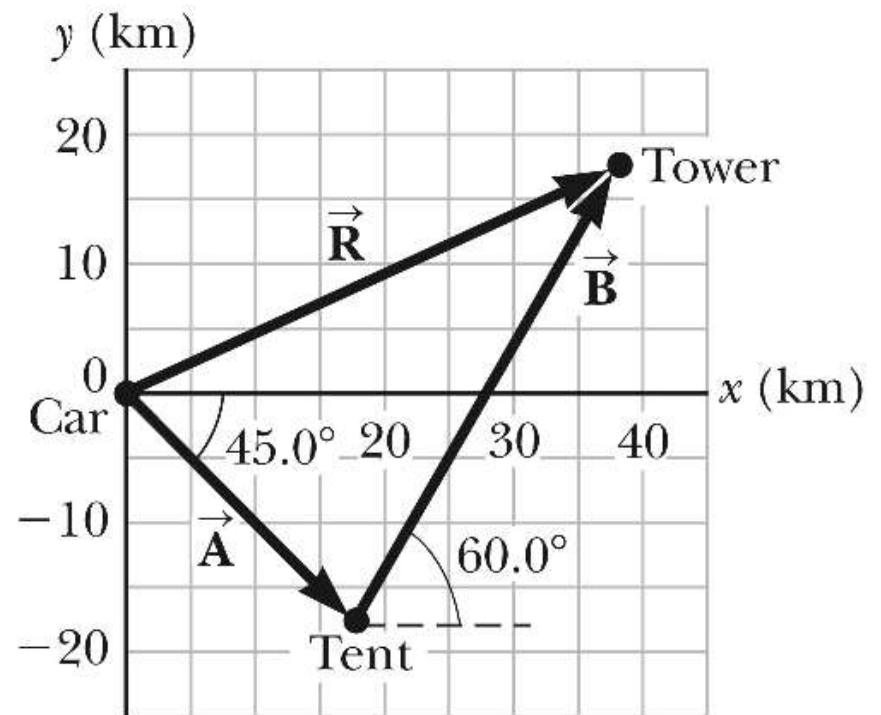
# Vectors



# Vectors

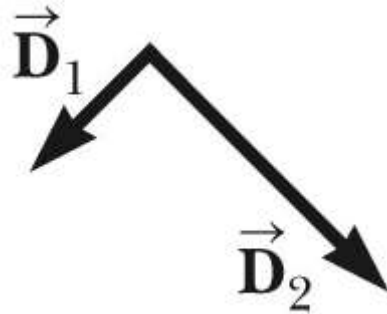
- Position:

$$\vec{R} = (37.7\hat{i} + 16.9\hat{j}) \text{ km}$$

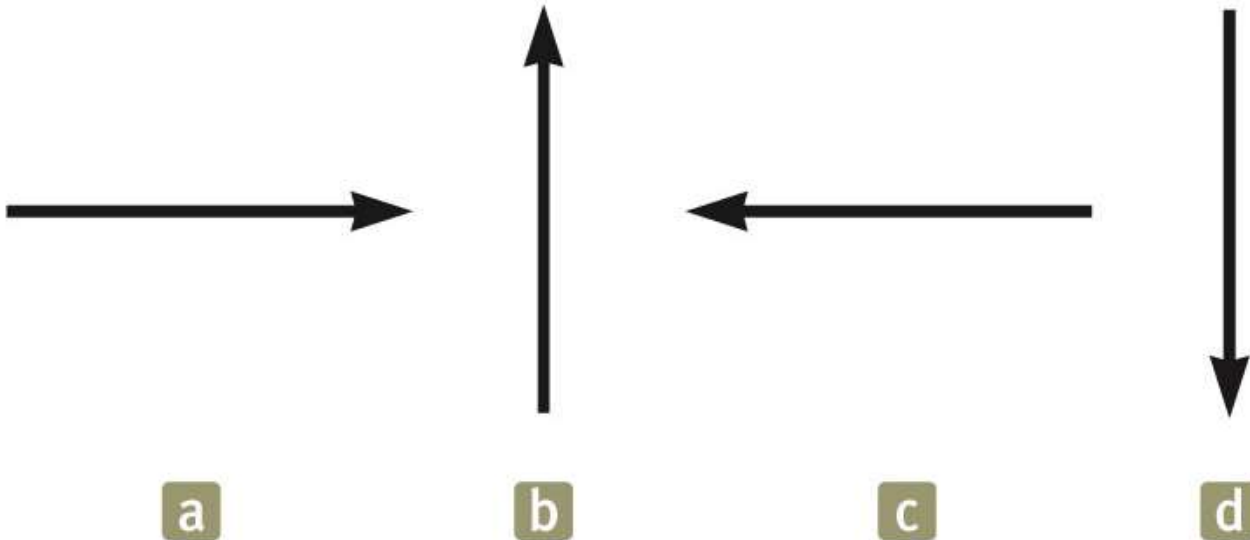


## Clicker Quiz

- The figure below shows two vectors  $\vec{D}_1$  and  $\vec{D}_2$ .

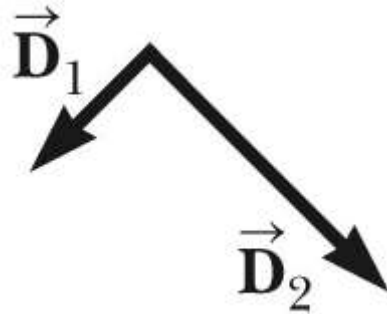


Which of the following vectors best shows  $\vec{D}_2 - 2\vec{D}_1$ ?



## Clicker Quiz

- The figure below shows two vectors  $\vec{D}_1$  and  $\vec{D}_2$ .



Which of the following vectors best shows  $\vec{D}_2 - 2\vec{D}_1$ ?

