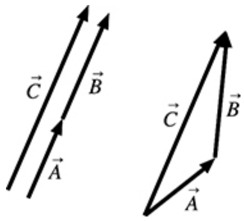
Chapter 3, Conceptual Questions

3.1. The magnitude of the displacement vector is the minimum distance traveled since the displacement is the vector sum of a number of individual movements. It is therefore not possible for the magnitude of the displacement vector to be more than the distance traveled. If the individual movements are all in the same direction, the total displacement and the distance traveled are equal. However, it is possible that the total displacement is less than the distance traveled, if the individual movements are not in the same direction.

3.2. It is possible that *C=A+B* only if $\vec{A}$ and $\vec{B}$ both point in the same direction as in the figure below. It is not possible that *C* > *A*+*B*, since if $\vec{A}$ and $\vec{B}$ point in different directions, putting them tip to tail gives a resultant with a shorter length (see figure below).



3.3. It is possible that *C=0* if $\vec{A} = -\vec{B}$. It is not possible for the length of a vector to be negative, so $C \geq 0$. Even if $\vec{A}$ and $\vec{B}$ are parallel but in opposite directions, $\vec{C}$ will still have a length greater than or equal to zero.

3.4. No, it is not possible to add a scalar to a vector, since the scalar has no direction.

3.5. The zero vector $\vec{0}$ has zero length. It does not point in any direction.

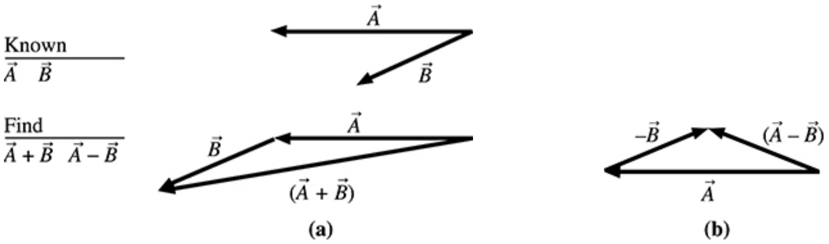
3.6. A vector can have a component that is zero and still have nonzero length only if another component is nonzero. For example, consider the vector $\hat{i} = (1,0)$, which points along the *x*-axis.

3.7. If one component of a vector is nonzero then it is not possible for the vector to have zero magnitude. The magnitude of the vector depends on the sum of the squares of the components, so any component signs do not matter.

3.8. No, it is not possible for two vectors with unequal magnitudes to add to zero. To add to zero, two vectors must be antiparallel and of the same length (magnitude).

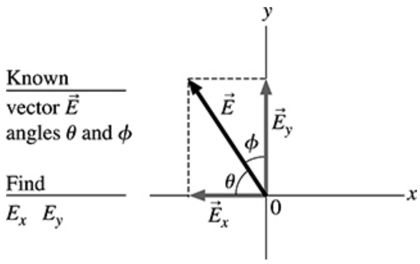
Chapter 3, Exercises and Problems

3.1. Visualize:



Solve: **(a)** To find $\vec{A}+\vec{B}$, we place the tail of vector $\vec{B}$ on the tip of vector $\vec{A}$ and connect the tail of vector $\vec{A}$ with the tip of vector $\vec{B}$.
(b) Since $\vec{A}-\vec{B}=\vec{A}+(-\vec{B})$, we place the tail of the vector $(-\vec{B})$ on the tip of vector $\vec{A}$ and then connect the tail of vector $\vec{A}$ with the tip of vector $(-\vec{B})$.

3.3. Visualize:



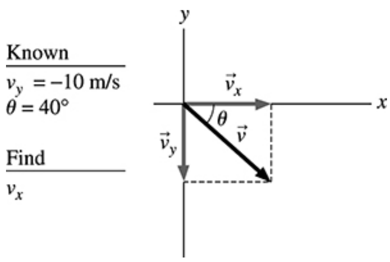
Solve: Vector $\vec{E}$ points to the left and up, so the components E_x and E_y are negative and positive, respectively, according to the Tactics Box 3.1.

(a) $E_x = -E\cos\theta$ and $E_y = E\sin\theta$.

(b) $E_x = -E\sin\phi$ and $E_y = E\cos\phi$.

Assess: Note that the role of sine and cosine are reversed because we are using a different angle. θ and ϕ are complementary angles.

3.5. Visualize: The figure shows the components v_x and v_y, and the angle θ.



Solve: We have, $v_y = -v\sin 40°$, or $-10 \text{ m/s} = -v\sin 40°$, or $v = 15.56$ m/s.

Thus the x-component is $v_x = v\cos 40° = (15.56 \text{ m/s})\cos 40° = 12$ m/s.

Assess: The x-component is positive since the position vector is in the fourth quadrant.

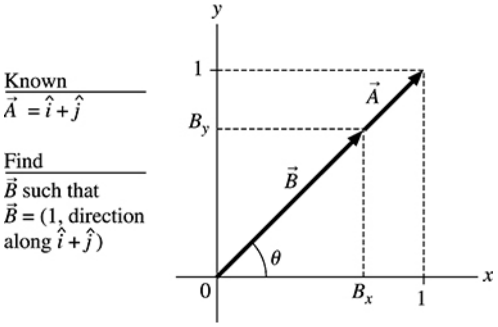
3.17. Solve: A different coordinate system can only mean a different orientation of the grid and a different origin of the grid.
(a) False, because the size of a vector is fixed.
(b) False, because the direction of a vector in space is independent of any coordinate system.
(c) True, because the orientation of the vector relative to the axes can be different.

3.19. Visualize: Refer to Figure EX3.19. The velocity vector $\vec{v}$ points west and makes an angle of 30° with the –*x*-axis. $\vec{v}$ points to the left and up, implying that v_x is negative and v_y is positive.

Solve: We have $v_x = -v\cos 30° = -(100 \text{ m/s})\cos 30° = -86.6 \text{ m/s}$ and $v_y = +v\sin 30° = (100 \text{ m/s})\sin 30° = 50.0 \text{ m/s}$.

Assess: v_x and v_y have the same units as $\vec{v}$.

3.29. Visualize:



The magnitude of the unknown vector is 1 and its direction is along $\hat{i} + \hat{j}$. Let $\vec{A} = \hat{i} + \hat{j}$ as shown in the diagram. That is, $\vec{A} = 1\hat{i} + 1\hat{j}$ and the *x*- and *y*-components of $\vec{A}$ are both unity. Since $\theta = \tan^{-1}(A_y / A_x) = 45°$, the unknown vector must make an angle of 45° with the +*x*-axis and have unit magnitude.

Solve: Let the unknown vector be $\vec{B} = B_x\hat{i} + B_y\hat{j}$ where

$$B_x = B\cos 45° = \frac{1}{\sqrt{2}}B \quad \text{and} \quad B_y = B\sin 45° = \frac{1}{\sqrt{2}}B$$

We want the magnitude of $\vec{B}$ to be 1, so we have

$$B = \sqrt{B_x^2 + B_y^2} = 1$$

$$\Rightarrow \sqrt{\left(\frac{1}{\sqrt{2}}B\right)^2 + \left(\frac{1}{\sqrt{2}}B\right)^2} = 1 \Rightarrow \sqrt{B^2} = 1 \Rightarrow B = 1$$

Hence,

$$B_x = B_y = \frac{1}{\sqrt{2}}$$

Finally,

$$\vec{B} = B_x\hat{i} + B_y\hat{j} = \frac{1}{\sqrt{2}}\hat{i} + \frac{1}{\sqrt{2}}\hat{j}$$