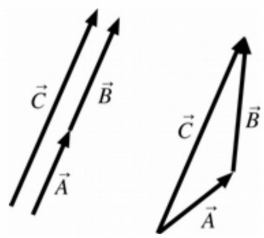
Conceptual Questions

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. Thus, it is 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.

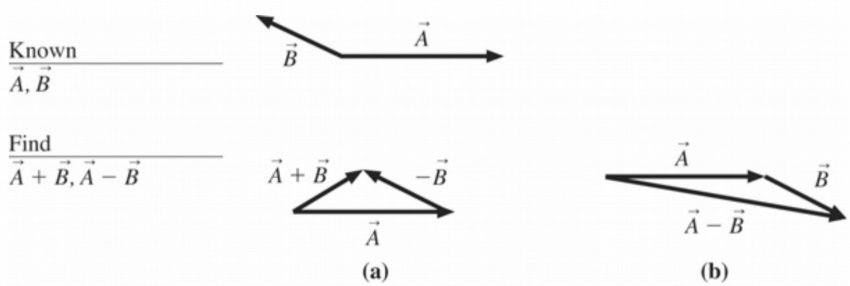
3.2. It is possible that $C = A + B$ only if $\vec{A}$ and $\vec{B}$ both point in the same direction as in the figure below. It is not possible that $C > A + B$ because, if $\vec{A}$ and $\vec{B}$ point in different directions, putting them tip to tail gives a resultant with a shorter length (see figure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



3.9. **(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.

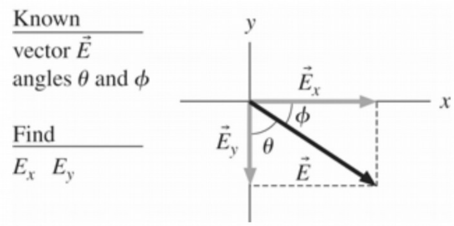
Exercises and Problems

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 draw an arrow from the tail of vector $\vec{A}$ to 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 draw an arrow from the tail of vector $\vec{A}$ to the tip of vector $-\vec{B}$.

3.3. Visualize:



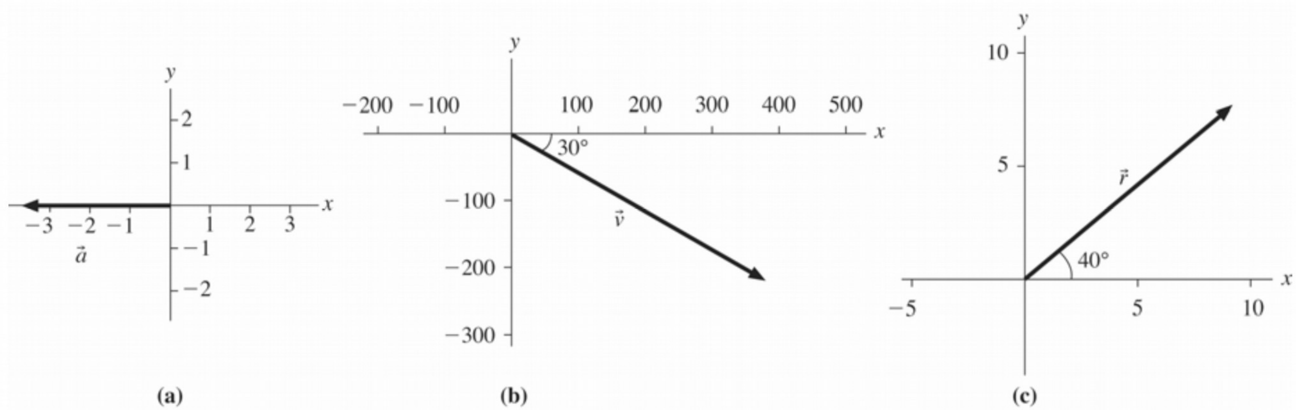
Solve: Vector $\vec{E}$ points to the right and down, so the components E_x and E_y are positive and negative, respectively, according to the Tactics Box 3.1.

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

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

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

3.6. Visualize:

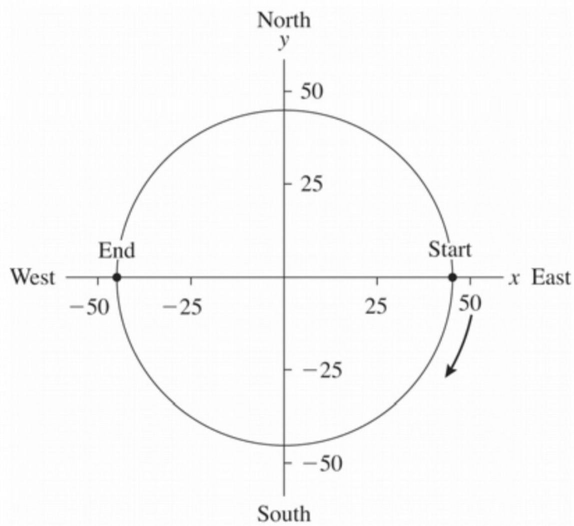


Solve: **(a)** $a_x = -3.5 \text{ m/s}^2$; $a_y = 0 \text{ m/s}^2$

(b) $v_x = (440 \text{ m/s})(\cos 30°) = 380 \text{ m/s}$; $v_y = -(440 \text{ m/s})(\sin 30°) = -220 \text{ m/s}$

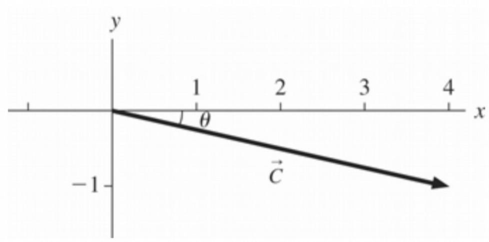
(c) $r_x = (12 \text{ m})(\cos 40°) = 9.2 \text{ m}$; $r_y = (12 \text{ m})(\sin 40°) = 7.7 \text{ m}$

3.9. Visualize:



Solve: The runner ends up at the point $(x, y) = (-50\text{ m}, 0\text{ m})$ after 2.5 times around (which is the same as 0.5 times around). The displacement from the starting point to the ending point is 100 m, west.
Assess: The position is only 50 m west of the origin, but the displacement goes from the first position to the last.

3.12. Visualize:



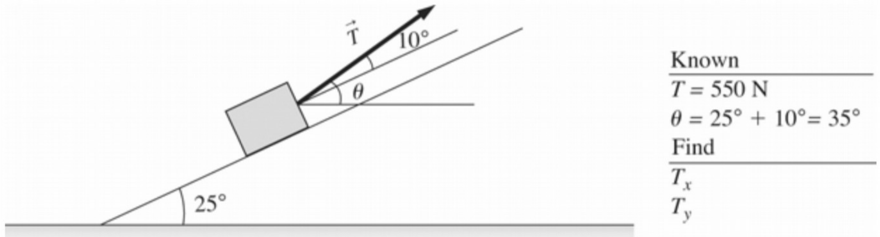
Solve: **(a)** $\vec{C} = (2\hat{i} + 3\hat{j}) + (2\hat{i} - 4\hat{j}) = (4\hat{i} - \hat{j})$

(b) Vector $\vec{C}$ is shown in the figure above.

(c) $C = \sqrt{(4.0)^2 + (-1.0)^2} = 4.1 \quad \theta = 14°$ below the $+x$-axis

3.38. Model: Model the crate as a particle.

Visualize:



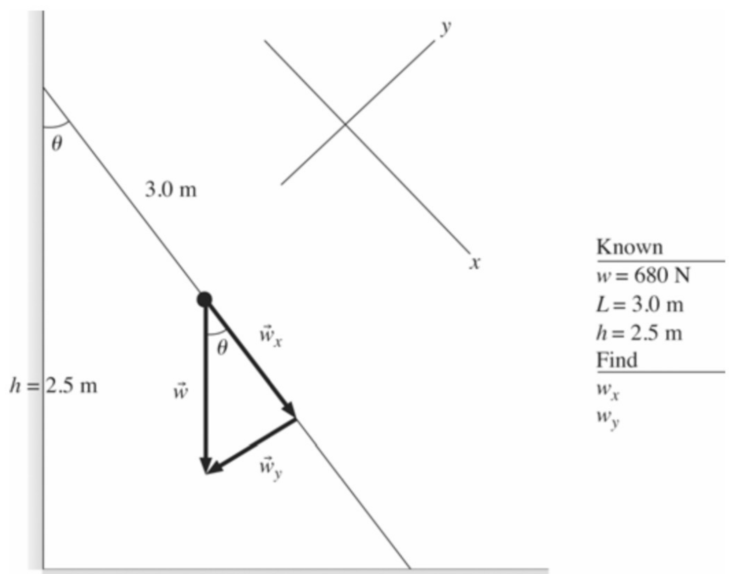
Solve: First find the angle from the horizontal: $\theta = 25^\circ + 10° = 35°$.

$$T_x = (550\ \text{N})\cos 35° = 450\ \text{N} \qquad T_y = (550\ \text{N})\sin 35° = 310\ \text{N}$$

Assess: The horizontal component of the tension would decrease if the angle of the ramp decreases or if the angle of the rope from the ramp decreases.

3.39. Model: Model Tom as a particle.

Visualize:



Solve: First find the angle of the ladder from the vertical: $\theta = \cos^{-1}\left(\frac{2.5\ \text{m}}{3.0\ \text{m}}\right) = 33.56°$.

$$w_x = (680\ \text{N})\cos 33.56° = 570\ \text{N} \qquad w_y = (680\ \text{N})\sin(-33.56°) = -380\ \text{N}$$

Assess: The figure could have been drawn differently to give negative values for both components; the magnitudes would be the same, however.