# Units, Measurement, and Vectors

1. You are a delivery person for the Fresh Aqua Spring Water Company. Your truck carries 4 pallets. Each pallet carries 60 cases of water. Each case of water has 24 one-liter bottles. The dolly you use to carry the water into the stores has a weight limit of 250 lb.
    a. If a milliliter of water has a mass of 1 g, and a kilogram has a weight of 2.2 lb, what is the weight, in pounds, of all the water in your truck?
    b. How many full cases of water can you carry on the cart?

2. Vectors $\vec{A}$ and $\vec{B}$ are shown in the figure. Vector $\vec{C}$ is given by $\vec{C} = B - A$. The magnitude of vector $\vec{A}$ is 16.0 units, and the magnitude of vector $\vec{B}$ is 7.00 units.
    a. What are the magnitude and components of vector $\vec{C}$?
    b. What is the angle of vector $\vec{C}$, measured counterclockwise from the +x-axis?
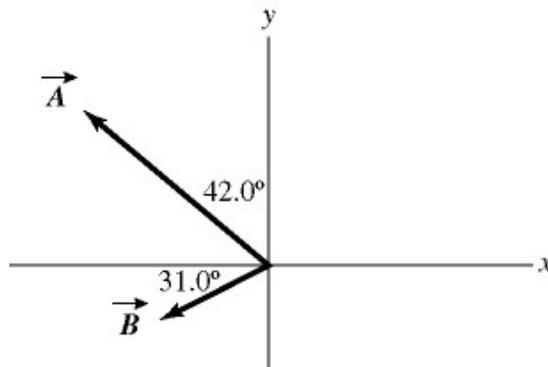
3. At Enormous State University (ESU), the football team records its plays using vector displacements, with the origin taken to be the position of the ball before the play starts. In a certain pass play, the receiver starts at +1.5 $\hat{\imath}$ - 3.0 $\hat{\jmath}$, where the units are yards, $\hat{\imath}$ is to the right, and $\hat{\jmath}$ is downfield. Subsequent displacements of the receiver are +9.0 $\hat{\imath}$ (in motion before the snap), +12 $\hat{\jmath}$ (breaks downfield), −6.0 $\hat{\imath}$ +4.0 $\hat{\jmath}$ (zigs), and +12.0 $\hat{\imath}$ +18.0 $\hat{\jmath}$ (zags). Meanwhile, the quarterback has dropped straight back to a position −7.0 $\hat{\jmath}$.
    a. How far must the quarterback throw the ball? (Like the coach, you will be well advised to diagram the situation before solving it numerically.) Express your answer using two significant figures.
    b. In which direction must the quarterback throw the ball? Express your answer using two significant figures.

4. All the stars of the Big Dipper (part of the constellation Ursa Major) may appear to be the same distance from the earth, but in fact they are very far from each other. The figure shows the distances from the earth to each of these stars. The distances are given in light years (ly), the distance that light travels in one year. One light year equals 9.461×10^{15} m.
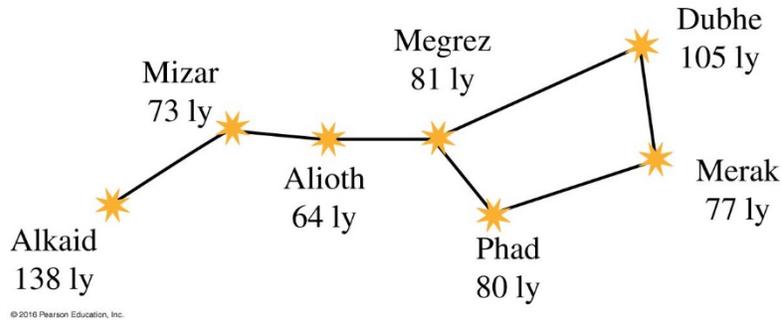
  a. Alkaid and Merak are 25.6° apart in the earth's sky. In a diagram, show the relative positions of Alkaid, Merak, and our sun. Find the distance in light years from Alkaid to Merak.
  b. To an inhabitant of a planet orbiting Merak, how many degrees apart in the sky would Alkaid and our sun be?

5. The scalar product of vectors $\vec{A}$ and $\vec{B}$ is +48.0 m^2. Vector $\vec{A}$ has magnitude 9.00 m and direction 28° west of south. If vector $\vec{B}$ has direction 39° south of east, what is the magnitude of $\vec{B}$?

6. Two vectors $\vec{A}$ and $\vec{B}$ have magnitudes $A = 3.00$ and $B = 3.00$. Their vector (cross) product is $\vec{A} \times \vec{B} = -5.00\,\hat{k} + 2.00\,\hat{\imath}$,. What is the angle between $\vec{A}$ and $\vec{B}$?

7. You are camping with Joe and Karl. Since all three of you like your privacy, you don't pitch your tents close together. Joe's tent is 21.0 m from yours, in the direction 23.0° south of east. Karl's tent is 32.0 m from yours, in the direction 37.0° north of east. What is the distance between Karl's tent and Joe's tent?

8. A teacher sends her students on a treasure hunt. She gives the following instructions: Walk 300 m north, then walk 400 m northwest, then walk 700 m east-southeast and the treasure is buried there. As all the other students walk off following the instructions, physics student Jane quickly adds the displacements and walks in a straight line to find the treasure. How far and in what direction does Jane need to walk?

9. Given three vectors: $\vec{A} = 4.00\,\hat{\imath} + 7.00\,\hat{\jmath}$, $\vec{B} = 5.00\,\hat{\imath} - 2.00\,\hat{\jmath}$, and $\vec{C} = 3.00\,\vec{A} - 4.00\,\vec{B}$,

  a. Find $\vec{A} \cdot \vec{B}$
  b. Find $\vec{B} \cdot \vec{C}$
  c. Find $\vec{A} \cdot \vec{C}$

10. For the vectors in problem 9, find the vector (cross) product $\vec{A} \times \vec{B}$. What is the magnitude of the vector product?