

Equating components, we get

$$-|\mathbf{T}_1| \cos 50^\circ + |\mathbf{T}_2| \cos 32^\circ = 0$$

$$|\mathbf{T}_1| \sin 50^\circ + |\mathbf{T}_2| \sin 32^\circ = 100$$

Solving the first of these equations for $|\mathbf{T}_2|$ and substituting into the second, we get

$$|\mathbf{T}_1| \sin 50^\circ + \frac{|\mathbf{T}_1| \cos 50^\circ}{\cos 32^\circ} \sin 32^\circ = 100$$

So the magnitudes of the tensions are

$$|\mathbf{T}_1| = \frac{100}{\sin 50^\circ + \tan 32^\circ \cos 50^\circ} \approx 85.64 \text{ lb}$$

and

$$|\mathbf{T}_2| = \frac{|\mathbf{T}_1| \cos 50^\circ}{\cos 32^\circ} \approx 64.91 \text{ lb}$$

Substituting these values in [5] and [6], we obtain the tension vectors

$$\mathbf{T}_1 \approx -55.05\mathbf{i} + 65.60\mathbf{j} \quad \mathbf{T}_2 \approx 55.05\mathbf{i} + 34.40\mathbf{j}$$

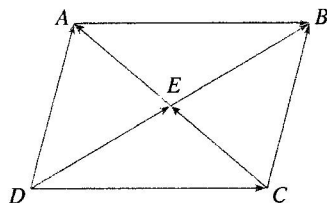
12.2 Exercises

1. Are the following quantities vectors or scalars? Explain.

- (a) The cost of a theater ticket
- (b) The current in a river
- (c) The initial flight path from Houston to Dallas
- (d) The population of the world

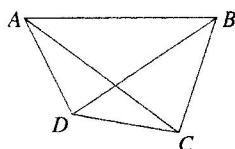
2. What is the relationship between the point (4, 7) and the vector $\langle 4, 7 \rangle$? Illustrate with a sketch.

3. Name all the equal vectors in the parallelogram shown.



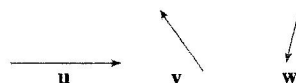
4. Write each combination of vectors as a single vector.

- (a) $\vec{AB} + \vec{BC}$
- (b) $\vec{CD} + \vec{DB}$
- (c) $\vec{DB} - \vec{AB}$
- (d) $\vec{DC} + \vec{CA} + \vec{AB}$



5. Copy the vectors in the figure and use them to draw the following vectors.

- (a) $\mathbf{u} + \mathbf{v}$
- (b) $\mathbf{u} + \mathbf{w}$
- (c) $\mathbf{v} + \mathbf{w}$
- (d) $\mathbf{u} - \mathbf{v}$
- (e) $\mathbf{v} + \mathbf{u} + \mathbf{w}$
- (f) $\mathbf{u} - \mathbf{w} - \mathbf{v}$

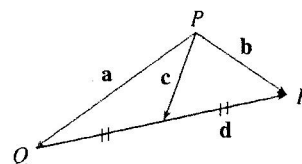


6. Copy the vectors in the figure and use them to draw the following vectors.

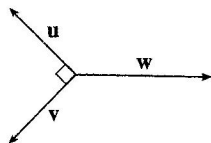
- (a) $\mathbf{a} + \mathbf{b}$
- (b) $\mathbf{a} - \mathbf{b}$
- (c) $\frac{1}{2}\mathbf{a}$
- (d) $-3\mathbf{b}$
- (e) $\mathbf{a} + 2\mathbf{b}$
- (f) $2\mathbf{b} - \mathbf{a}$



7. In the figure, the tip of \mathbf{c} and the tail of \mathbf{d} are both the midpoint of QR . Express \mathbf{c} and \mathbf{d} in terms of \mathbf{a} and \mathbf{b} .



8. If the vectors in the figure satisfy $|\mathbf{u}| = |\mathbf{v}| = 1$ and $\mathbf{u} + \mathbf{v} + \mathbf{w} = \mathbf{0}$, what is $|\mathbf{w}|$?



- 9–14 Find a vector \mathbf{a} with representation given by the directed line segment \overrightarrow{AB} . Draw \overrightarrow{AB} and the equivalent representation starting at the origin.

9. $A(-1, 1)$, $B(3, 2)$ 10. $A(-4, -1)$, $B(1, 2)$
 11. $A(-1, 3)$, $B(2, 2)$ 12. $A(2, 1)$, $B(0, 6)$
 13. $A(0, 3, 1)$, $B(2, 3, -1)$ 14. $A(4, 0, -2)$, $B(4, 2, 1)$

- 15–18 Find the sum of the given vectors and illustrate geometrically.

15. $\langle -1, 4 \rangle$, $\langle 6, -2 \rangle$ 16. $\langle 3, -1 \rangle$, $\langle -1, 5 \rangle$
 17. $\langle 3, 0, 1 \rangle$, $\langle 0, 8, 0 \rangle$ 18. $\langle 1, 3, -2 \rangle$, $\langle 0, 0, 6 \rangle$

- 19–22 Find $\mathbf{a} + \mathbf{b}$, $2\mathbf{a} + 3\mathbf{b}$, $|\mathbf{a}|$, and $|\mathbf{a} - \mathbf{b}|$.

19. $\mathbf{a} = \langle 5, -12 \rangle$, $\mathbf{b} = \langle -3, -6 \rangle$
 20. $\mathbf{a} = 4\mathbf{i} + \mathbf{j}$, $\mathbf{b} = \mathbf{i} - 2\mathbf{j}$
 21. $\mathbf{a} = \mathbf{i} + 2\mathbf{j} - 3\mathbf{k}$, $\mathbf{b} = -2\mathbf{i} - \mathbf{j} + 5\mathbf{k}$
 22. $\mathbf{a} = 2\mathbf{i} - 4\mathbf{j} + 4\mathbf{k}$, $\mathbf{b} = 2\mathbf{j} - \mathbf{k}$

- 23–25 Find a unit vector that has the same direction as the given vector.

23. $-3\mathbf{i} + 7\mathbf{j}$ 24. $\langle -4, 2, 4 \rangle$
 25. $8\mathbf{i} - \mathbf{j} + 4\mathbf{k}$

26. Find a vector that has the same direction as $\langle -2, 4, 2 \rangle$ but has length 6.

- 27–28 What is the angle between the given vector and the positive direction of the x -axis?

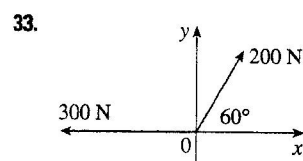
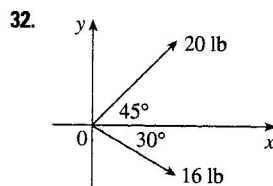
27. $\mathbf{i} + \sqrt{3}\mathbf{j}$ 28. $8\mathbf{i} + 6\mathbf{j}$

29. If \mathbf{v} lies in the first quadrant and makes an angle $\pi/3$ with the positive x -axis and $|\mathbf{v}| = 4$, find \mathbf{v} in component form.

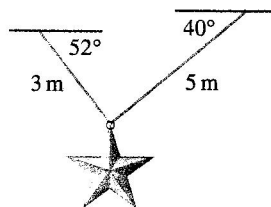
30. If a child pulls a sled through the snow on a level path with a force of 50 N exerted at an angle of 38° above the horizontal, find the horizontal and vertical components of the force.

31. A quarterback throws a football with angle of elevation 40° and speed 60 ft/s. Find the horizontal and vertical components of the velocity vector.

- 32–33 Find the magnitude of the resultant force and the angle it makes with the positive x -axis.



34. The magnitude of a velocity vector is called *speed*. Suppose that a wind is blowing from the direction $N45^\circ W$ at a speed of 50 km/h. (This means that the direction from which the wind blows is 45° west of the northerly direction.) A pilot is steering a plane in the direction $N60^\circ E$ at an airspeed (speed in still air) of 250 km/h. The *true course*, or *track*, of the plane is the direction of the resultant of the velocity vectors of the plane and the wind. The *ground speed* of the plane is the magnitude of the resultant. Find the true course and the ground speed of the plane.
35. A woman walks due west on the deck of a ship at 3 mi/h. The ship is moving north at a speed of 22 mi/h. Find the speed and direction of the woman relative to the surface of the water.
36. Ropes 3 m and 5 m in length are fastened to a holiday decoration that is suspended over a town square. The decoration has a mass of 5 kg. The ropes, fastened at different heights, make angles of 52° and 40° with the horizontal. Find the tension in each wire and the magnitude of each tension.



37. A clothesline is tied between two poles, 8 m apart. The line is quite taut and has negligible sag. When a wet shirt with a mass of 0.8 kg is hung at the middle of the line, the midpoint is pulled down 8 cm. Find the tension in each half of the clothesline.
38. The tension T at each end of the chain has magnitude 25 N (see the figure). What is the weight of the chain?



39. A boatman wants to cross a canal that is 3 km wide and wants to land at a point 2 km upstream from his starting point. The current in the canal flows at 3.5 km/h and the speed of his boat is 13 km/h.
- (a) In what direction should he steer?
- (b) How long will the trip take?