In Exercises 1–4, let **u** be the vector represented by the directed line segment $\overrightarrow{RS}$ and **v** be the vector represented by the directed line segment $\overrightarrow{OP}$. Prove that $\mathbf{u} = \mathbf{v}$.

1. $R = (-4, 7)$, $S = (-1, 5)$, $O = (0, 0)$, and $P = (3, -2)$
2. $R = (7, -3)$, $S = (4, -5)$, $O = (0, 0)$, and $P = (-3, -2)$
3. $R = (2, 1)$, $S = (0, -1)$, $O = (1, 4)$, and $P = (-1, 2)$
4. $R = (-2, -1)$, $S = (2, 4)$, $O = (-3, -1)$, and $P = (1, 4)$

In Exercises 5–12, let $P = (-2, 2)$, $Q = (3, 4)$, $R = (-2, 5)$, and $S = (2, -8)$. Find the component form and magnitude of the vector.

5. $\overrightarrow{PQ}$
6. $\overrightarrow{RS}$
7. $\overrightarrow{QR}$
8. $\overrightarrow{PS}$
9. $2\overrightarrow{QS}$
10. $(\sqrt{2})\overrightarrow{PR}$
11. $3\overrightarrow{QR} + \overrightarrow{PS}$
12. $\overrightarrow{PS} - 3\overrightarrow{PQ}$

In Exercises 13–20, let $\mathbf{u} = \langle -1, 3 \rangle$, $\mathbf{v} = \langle 2, 4 \rangle$, and $\mathbf{w} = \langle 2, -5 \rangle$. Find the component form of the vector.

13. $\mathbf{u} + \mathbf{v}$
14. $\mathbf{u} + (-1)\mathbf{v}$
15. $\mathbf{u} - \mathbf{w}$
16. $3\mathbf{v}$
17. $2\mathbf{u} + 3\mathbf{w}$
18. $2\mathbf{u} - 4\mathbf{v}$
19. $-2\mathbf{u} - 3\mathbf{v}$
20. $-\mathbf{u} - \mathbf{v}$

In Exercises 21–24, find a unit vector in the direction of the given vector.

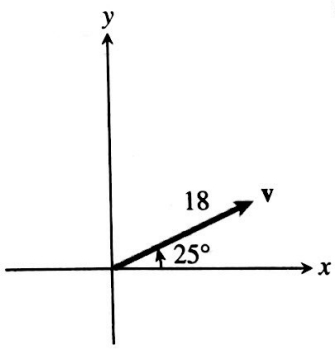
21. $\mathbf{u} = \langle -2, 4 \rangle$
22. $\mathbf{v} = \langle 1, -1 \rangle$
23. $\mathbf{w} = -\mathbf{i} - 2\mathbf{j}$
24. $\mathbf{w} = 5\mathbf{i} + 5\mathbf{j}$

In Exercises 25–28, find the unit vector in the direction of the given vector. Write your answer in **(a)** component form and **(b)** as a linear combination of the standard unit vectors **i** and **j**.

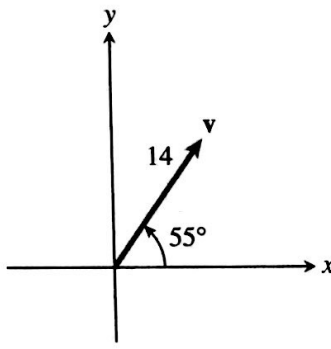
25. $\mathbf{u} = \langle 2, 1 \rangle$
26. $\mathbf{u} = \langle -3, 2 \rangle$
27. $\mathbf{u} = \langle -4, -5 \rangle$
28. $\mathbf{u} = \langle 3, -4 \rangle$

In Exercises 29–32, find the component form of the vector **v**.

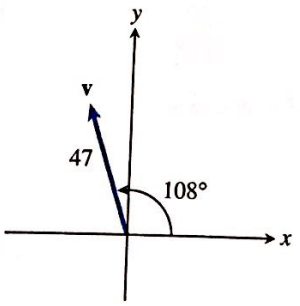
29.



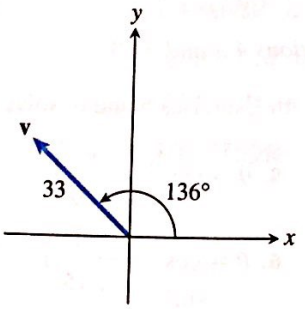
30.



31.



32.



In Exercises 33–38, find the magnitude and direction angle of the vector.

33. $\langle 3, 4 \rangle$

34. $\langle -1, 2 \rangle$

35. $3\mathbf{i} - 4\mathbf{j}$

36. $-3\mathbf{i} - 5\mathbf{j}$

37. $7(\cos 135° \mathbf{i} + \sin 135° \mathbf{j})$

38. $2(\cos 60° \mathbf{i} + \sin 60° \mathbf{j})$

In Exercises 39 and 40, find the vector $\mathbf{v}$ with the given magnitude and the same direction as $\mathbf{u}$.

39. $|\mathbf{v}| = 2, \mathbf{u} = \langle 3, -3 \rangle$

40. $|\mathbf{v}| = 5, \mathbf{u} = \langle -5, 7 \rangle$

41. Navigation An airplane is flying on a bearing of 335° at 530 mph. Find the component form of the velocity of the airplane.

42. Navigation An airplane is flying on a bearing of 170° at 460 mph. Find the component form of the velocity of the airplane.

43. Flight Engineering An airplane is flying on a compass heading (bearing) of 340° at 325 mph. A wind is blowing with the bearing 320° at 40 mph.

(a) Find the component form of the velocity of the airplane.

(b) Find the actual ground speed and direction of the plane.

44. Flight Engineering An airplane is flying on a compass heading (bearing) of 170° at 460 mph. A wind is blowing with the bearing 200° at 80 mph.

(a) Find the component form of the velocity of the airplane.

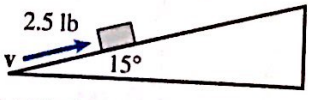
(b) Find the actual ground speed and direction of the airplane.

45. Shooting a Basketball A basketball is shot at a 70° angle with the horizontal direction with an initial speed of 10 m/sec.

(a) Find the component form of the initial velocity.

(b) Writing to Learn Give an interpretation of the horizontal and vertical components of the velocity.

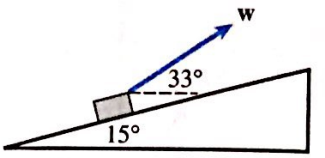
46. Moving a Heavy Object In a warehouse a box is being pushed up a 15° inclined plane with a force of 2.5 lb, as shown in the figure.



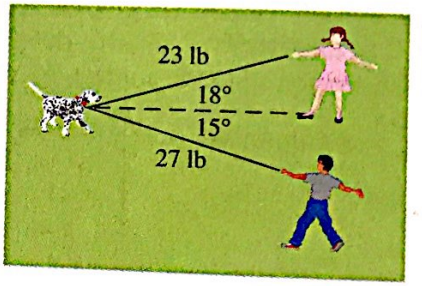
(a) Find the component form of the force.

(b) Writing to Learn Give an interpretation of the horizontal and vertical components of the force.

47. Moving a Heavy Object Suppose the box described in Exercise 46 is being towed up the inclined plane, as shown in the figure below. Find the force $\mathbf{w}$ needed in order for the component of the force parallel to the inclined plane to be 2.5 lb. Give the answer in component form.



48. Combining Forces Juana and Diego Gonzales, ages six and four respectively, own a strong and stubborn puppy named Corporal. It is so hard to take Corporal for a walk that they devise a scheme to use two leashes. If Juana and Diego pull with forces of 23 lb and 27 lb at the angles shown in the figure, how hard is Corporal pulling if the puppy holds the children at a standstill?



In Exercises 49 and 50, find the direction and magnitude of the resultant force.

49. Combining Forces A force of 50 lb acts on an object at an angle of 45°. A second force of 75 lb acts on the object at an angle of −30°.

50. Combining Forces Three forces with magnitudes 100, 50, and 80 lb, act on an object at angles of 50°, 160°, and −20°, respectively.

51. Navigation A ship is heading due north at 12 mph. The current is flowing southwest at 4 mph. Find the actual bearing and speed of the ship.

52. Navigation A motor boat capable of 20 mph keeps the bow of the boat pointed straight across a mile-wide river. The current is flowing left to right at 8 mph. Find where the boat meets the opposite shore.

53. Group Activity A ship heads due south with the current flowing northwest. Two hours later the ship is 20 miles in the direction 30° west of south from the original starting point. Find the speed with no current of the ship and the rate of the current.

54. Group Activity Use component form and prove the following properties of vectors.

(a) $\mathbf{u} + \mathbf{v} = \mathbf{v} + \mathbf{u}$

(b) $(\mathbf{u} + \mathbf{v}) + \mathbf{w} = \mathbf{u} + (\mathbf{v} + \mathbf{w})$

(c) $\mathbf{u} + \mathbf{0} = \mathbf{u}$, where $\mathbf{0} = \langle 0, 0 \rangle$