**Vocabulary:** Fill in the blanks.

1. The ________ ________ of two vectors yields a scalar, rather than a vector.
2. The dot product of $\mathbf{u} = \langle u_1, u_2 \rangle$ and $\mathbf{v} = \langle v_1, v_2 \rangle$ is $\mathbf{u} \cdot \mathbf{v} =$ ________ .
3. If $\theta$ is the angle between two nonzero vectors **u** and **v**, then $\cos\theta =$ ________ .
4. The vectors **u** and **v** are ________ when $\mathbf{u} \cdot \mathbf{v} = 0$.
5. The projection of **u** onto **v** is given by $\text{proj}_{\mathbf{v}}\mathbf{u} =$ ________ .
6. The work $W$ done by a constant force **F** as its point of application moves along the vector $\overrightarrow{PQ}$ is given by $W =$ ________ or $W =$ ________ .

**Finding a Dot Product** In Exercises 7–14, find $\mathbf{u} \cdot \mathbf{v}$.

7. $\mathbf{u} = \langle 7, 1 \rangle$, $\mathbf{v} = \langle -3, 2 \rangle$
8. $\mathbf{u} = \langle 6, 10 \rangle$, $\mathbf{v} = \langle -2, 3 \rangle$
11. $\mathbf{u} = 4\mathbf{i} - 2\mathbf{j}$, $\mathbf{v} = \mathbf{i} - \mathbf{j}$

**Using Properties of Dot Products** In Exercises 15–24, use the vectors $\mathbf{u} = \langle 3, 3 \rangle$, $\mathbf{v} = \langle -4, 2 \rangle$, and $\mathbf{w} = \langle 3, -1 \rangle$ to find the indicated quantity. State whether the result is a vector or a scalar.

15. $\mathbf{u} \cdot \mathbf{u}$
16. $3\mathbf{u} \cdot \mathbf{v}$
17. $(\mathbf{u} \cdot \mathbf{v})\mathbf{v}$
18. $(\mathbf{v} \cdot \mathbf{u})\mathbf{w}$
22. $2 - \|\mathbf{u}\|$
23. $(\mathbf{u} \cdot \mathbf{v}) - (\mathbf{u} \cdot \mathbf{w})$
24. $(\mathbf{v} \cdot \mathbf{u}) - (\mathbf{w} \cdot \mathbf{v})$

**Finding the Angle Between Two Vectors** In Exercises 31–40, find the angle $\theta$ between the vectors.

31. $\mathbf{u} = \langle 1, 0 \rangle$, $\mathbf{v} = \langle 0, -2 \rangle$
32. $\mathbf{u} = \langle 3, 2 \rangle$, $\mathbf{v} = \langle 4, 0 \rangle$

**Finding the Angle Between Two Vectors** In Exercises 41–44, graph the vectors and find the degree measure of the angle $\theta$ between the vectors.

42. $\mathbf{u} = 6\mathbf{i} + 3\mathbf{j}$, $\mathbf{v} = -4\mathbf{i} + 4\mathbf{j}$

**Finding the Angles in a Triangle** In Exercises 45–48, use vectors to find the interior angles of the triangle with the given vertices.

45. $(1, 2), (3, 4), (2, 5)$
46. $(-3, -4), (1, 7), (8, 2)$

**Using the Angle Between Two Vectors** In Exercises 49–52, find $\mathbf{u} \cdot \mathbf{v}$, where $\theta$ is the angle between **u** and **v**.

49. $\|\mathbf{u}\| = 4$, $\|\mathbf{v}\| = 10$, $\theta = \dfrac{2\pi}{3}$
50. $\|\mathbf{u}\| = 100$, $\|\mathbf{v}\| = 250$, $\theta = \dfrac{\pi}{6}$

**Determining Orthogonal Vectors** In Exercises 53–58, determine whether **u** and **v** are orthogonal.

58. $\mathbf{u} = \langle \cos\theta, \sin\theta \rangle$, $\mathbf{v} = \langle \sin\theta, -\cos\theta \rangle$

**Decomposing a Vector into Components** In Exercises 59–62, find the projection of **u** onto **v**. Then write **u** as the sum of two orthogonal vectors, one of which is $\text{proj}_{\mathbf{v}}\mathbf{u}$.

59. $\mathbf{u} = \langle 2, 2 \rangle$, $\mathbf{v} = \langle 6, 1 \rangle$
60. $\mathbf{u} = \langle 4, 2 \rangle$, $\mathbf{v} = \langle 1, -2 \rangle$