1. Consider the vector
\[ a = 4\mathbf{i} - 5\mathbf{j} + 6\mathbf{k}. \]

(a) Find the vector that has the same direction as \( a \) and twice the magnitude of \( a \).

(b) Find the vector that has the opposite direction of \( a \) and one-third the magnitude of \( a \).

(c) Find the vector that has the same direction as \( a \) and magnitude 3.

2. Calculate the following quantities if
\[ a = (1, 1, -2) \quad \text{and} \quad b = (3, -2, 1). \]

(a) \( 2a + 3b \)

(b) \( \|b\| \)
3. If \( \mathbf{u} \) and \( \mathbf{v} \) are the vectors shown in the figure, find \( \mathbf{u} \cdot \mathbf{v} \),

\[
|\mathbf{V}| = 3 \\
\pi/4 \\
|\mathbf{U}| = 2
\]

4. Consider the vectors in the \( xy \)-plane shown below. Express the following vector sums as a scalar multiple of just one of the six vectors.

(a) \( \mathbf{a} + \mathbf{b} \)
5. Show that \( \mathbf{a} \) and \( \mathbf{b} \) are orthogonal, where
\[
\mathbf{a} = 3\mathbf{i} - 2\mathbf{j} + \mathbf{k} \quad \text{and} \quad \mathbf{b} = 4\mathbf{i} + 5\mathbf{j} - 2\mathbf{k}
\]

6. Find the values of \( x \) such that the vectors \( \langle 3, 2, x \rangle \) and \( \langle 2x, 4, x \rangle \) are orthogonal.

7. Find the angle between the diagonal of a cube and one of its edges.