3. (a) Find the equation of the line through $(-1, 2, -1)$ in the direction of $\mathbf{j}$.
(b) Find the equation of the line passing through $(0, 2, -1)$ and $(-3, 1, 0)$.
(c) Find the equation for the plane perpendicular to the vector $(-2, 1, 2)$ and passing through the point $(-1, 1, 3)$.

4. (a) Find the equation of the line through $(0, 1, 0)$ in the direction of $3\mathbf{i} + \mathbf{k}$.
(b) Find the equation of the line passing through $(0, 1, 1)$ and $(0, 1, 0)$.
(c) Find an equation for the plane perpendicular to the vector $(-1, 1, -1)$ and passing through the point $(1, 1, 1)$.

5. Compute $\mathbf{v} \cdot \mathbf{w}$ for the following sets of vectors:

(a) $\mathbf{v} = -\mathbf{i} + \mathbf{j}$; $\mathbf{w} = \mathbf{k}$.
(b) $\mathbf{v} = \mathbf{i} + 2\mathbf{j} - \mathbf{k}$; $\mathbf{w} = 3\mathbf{i} + \mathbf{j}$.
(c) $\mathbf{v} = -2\mathbf{i} - \mathbf{j} + \mathbf{k}$; $\mathbf{w} = 3\mathbf{i} + 2\mathbf{j} - 2\mathbf{k}$.

6. Compute $\mathbf{v} \times \mathbf{w}$ for the vectors in Exercise 5. [Only part (b) is solved in the Study Guide.]

7. Find the cosine of the angle between the vectors in Exercise 5. [Only part (b) is solved in the Study Guide.]

8. Find the area of the parallelogram spanned by the vectors in Exercise 5. [Only part (b) is solved in the Study Guide.]

9. Use vector notation to describe the triangle in space whose vertices are the origin and the endpoints of vectors $\mathbf{a}$ and $\mathbf{b}$.

10. Show that three vectors $\mathbf{a}, \mathbf{b}, \mathbf{c}$ lie in the same plane through the origin if and only if there are three scalars α, β, γ, not all zero, such that $\alpha\mathbf{a} + \beta\mathbf{b} + \gamma\mathbf{c} = \mathbf{0}$.

11. For real numbers $a_1, a_2, a_3, b_1, b_2, b_3$, show that

$$(a_1b_1 + a_2b_2 + a_3b_3)^2 \le (a_1^2 + a_2^2 + a_3^2)(b_1^2 + b_2^2 + b_3^2).$$

12. Let $\mathbf{u}, \mathbf{v}, \mathbf{w}$ be unit vectors that are orthogonal to each other. If $\mathbf{a} = \alpha\mathbf{u} + \beta\mathbf{v} + \gamma\mathbf{w}$, show that

$$\alpha = \mathbf{a} \cdot \mathbf{u}, \qquad \beta = \mathbf{a} \cdot \mathbf{v}, \qquad \gamma = \mathbf{a} \cdot \mathbf{w}.$$

Interpret the results geometrically.

13. Let $\mathbf{a}, \mathbf{b}$ be two vectors in the plane, $\mathbf{a} = (a_1, a_2)$, $\mathbf{b} = (b_1, b_2)$, and let λ be a real number. Show that the area of the parallelogram determined by $\mathbf{a}$ and $\mathbf{b} + \lambda\mathbf{a}$ is the same as that determined by $\mathbf{a}$ and $\mathbf{b}$. Sketch. Relate this result to a known property of determinants.

14. Find the volume of the parallelepiped determined by the vertices $(0, 1, 0)$, $(1, 1, 1)$, $(0, 2, 0)$, $(3, 1, 2)$.

15. Given nonzero vectors $\mathbf{a}$ and $\mathbf{b}$ in $\mathbb{R}^3$, show that the vector $\mathbf{v} = \|\mathbf{a}\|\mathbf{b} + \|\mathbf{b}\|\mathbf{a}$ bisects the angle between $\mathbf{a}$ and $\mathbf{b}$.