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

2. Show that the vectors $|\mathbf{b}|\mathbf{a} + |\mathbf{a}|\mathbf{b}$ and $|\mathbf{b}|\mathbf{a} - |\mathbf{a}|\mathbf{b}$ are orthogonal.

3. Find an equation of the plane that contains the point $P(3, -1, 2)$ and the line
   $\mathbf{r}(t) = \langle 2, -1, 0 \rangle + t\langle 2, 3, 0 \rangle$.

4. Find a unit vector that is parallel to both the planes $8x + y + z = 1$ and $x - y - z = 0$.

5. Find a unit vector that makes an angle of $30°$ with $\hat{\mathbf{i}}$ and makes equal angles with $\hat{\mathbf{j}}$ and $\hat{\mathbf{k}}$.

6. Let $f(x, y) = x^2 e^{-xy}$

7. (a) Find a normal to the surface $z = f(x, y)$ at the point $(1, 2)$.

   (b) Find the equation of the tangent plane to the surface $z = f(x, y)$ at the point $(1, 2)$.

   (c) What point on the surface $z = x^2 - y^2$ has a tangent plane parallel to the plane in (b)?

8. Find an equation of the tangent plane to $(\cos x)(\cos y)e^z = 0$ at $(\pi/2, 1, 0)$.

9. At time $t = 0$ a particle is ejected from the surface $x^2 + 2y^2 + 3z^2 = 6$ at the point $(1, 1, 1)$ in a direction normal to the surface at a speed of 10 units per second. At what time does the particle first reach the surface of the sphere $x^2 + y^2 = z^2 = 103$?

10. Let $f(x, y) = 5ye^x - e^{5x} - y^5$. Show that f has a unique critical point corresponding to a local maximum, but that f has no absolute maximum.