1. Let $\vec{u} = \langle 1, 4, 2\rangle$, $\vec{v} = \langle -2, 3, 1\rangle$, and $\vec{w} = \langle 4, -1, -1\rangle$. Perform the indicated operations.

   (a) Calculate $(2\vec{u} + 3\vec{v}) \cdot \vec{w}$.

   (b) Compute the angle (in degrees) between $\vec{u}$ and $\vec{v}$.

   (c) Calculate $\vec{v} \times \vec{w}$.

   (d) Find the volume of the parallelepiped determined by $\vec{u}$, $\vec{v}$, and $\vec{w}$.

2. Let $\vec{u} = \langle 3, 4 \rangle$ and $\vec{v} = \langle 5, 12 \rangle$. We can write $\vec{u} = \vec{w} + \vec{n}$, where $\vec{w}$ is parallel to $\vec{v}$ and $\vec{n}$ is perpendicular to $\vec{v}$. Find $\vec{w}$ and $\vec{n}$.

3. Find the equation of the plane that passes through the points $P = (1, 4, 6)$, $Q = (-2, 5, -1)$, and $R = (1, -1, 1)$.

4. A particle P travels in the plane, and its vector position at time t is given by $\vec{r}(t) = (1-t)\vec{i} + \sqrt{1-t^2}\vec{j}$.

   (a) Find the Cartesian equation for the path of the particle.

   (b) Assuming that P starts moving at time $t = 0$, how far will it have traveled at $t = 1/2$ seconds?

5. A small kid who goes by the nickname Triple A is going sledding. It is a quarter-mile (1320 feet) walk from his house to get to the sledding hill. He exerts 15 pounds of force by pulling the sled. The sled is tied to a 5 foot rope, and the hand that he pulls the rope with is 3 feet above the ground. How much work does Triple A do in pulling the sled? Assume that the ground is flat from his house to the sledding hill, and don't worry about friction.

6. Find the parametric equations of the line of intersection between the planes $x - 2y + 4z = 14$ and $-x + 2y - 5z = -30$.

7. For each of the following, write the equations in a standard form, and identify the surface in space they describe. You don't need to graph them.

   (a) $441x^2 + 144y^2 + 784z^2 - 7056 = 0.$

   (b) $7x - 4y^2 + 3z^2 = 0$

   (c) $x^2 + z^2 - 8x + 4z + 13 = 0$

   (d) $2x^2 + 2y^2 + 2z^2 - 12x - 6y + 28z + 81 = 0$

8. A cannon sits atop a cliff that is 176 feet tall. It is aimed at an angle of 53.1301° above the horizontal, and it shoots a projectile at the speed of 25 feet per second.

   (a) Find the initial velocity vector of the projectile.

   (b) Using part(a), the fact that $\vec{a}(t) = -32\vec{j}$, and assuming $\vec{r}(0) = 176\vec{j}$, find the velocity, $\vec{v}(t)$, and the position, $\vec{r}(t)$, of the projectile for any time t.

   (c) At what time does the projectile hit the ground?

   (d) With what speed does the projectile come smashing into the basin below the cliff?

9. Let $\vec{r}(t) = t\vec{i} + t^2\vec{j} + \frac{2}{3}t^3\vec{k}$.

(a) Find $\vec{T}(1)$.

(b) Find $\vec{N}(t)$.

(c) Find the curvature, κ at $t = 1$.

(d) Find the binormal $\vec{B}(1)$.