0. (1 point) Carefully read and complete the instructions on this exam and any additional instructions announced during the exam.

1. (6 points) Consider the vectors \( \vec{v} = 2i + j - 2k \) and \( \vec{w} = i + 2j + 2k \).
   (a) Compute \( \vec{v} \times \vec{w} \).
   (b) Determine the area of the parallelogram spanned by \( \vec{v} \) and \( \vec{w} \).
   (c) Find a vector that is orthogonal to both \( \vec{v} \) and \( \vec{v} \times \vec{w} \).

2. (6 points) Let \( P = (0, 2, -1) \) and \( Q = (-3, 1, 0) \) be two points in \( \mathbb{R}^3 \).
   (a) Find a vector parameterization for the line that passes through \( P \) and \( Q \).
   (b) Find an equation for the plane orthogonal to the line passing through \( P \) and \( Q \) that passes through the point \( Q \).

3. (6 points) Evaluate \( \lim_{(x,y) \to (0,0)} \frac{2xy}{x^2 + y^2} \) or explain why the limit does not exist.

4. (6 points) Let \( \vec{u} \) and \( \vec{v} \) be two unit vectors such that \( \|\vec{u} + \vec{v}\| = \frac{2}{3} \). Find \( \|\vec{u} - \vec{v}\| \).

5. (6 points) Determine if the lines given by these vector parameteric formulas intersect. If so, find the point where they intersect.
   \[ \vec{r}_1(t) = \langle -9, 6, -8 \rangle + t \langle 4, -1, 3 \rangle \quad \text{and} \quad \vec{r}_2(t) = \langle 7, 0, 2 \rangle + t \langle 2, -1, 1 \rangle \]