Directions. Please work on the problems below. Your solutions must begin with a clear statement of the problem, followed by a clear, legible solution (or partial progress towards a solution). Please refer to the syllabus for the policy on grading and late homework.

Collaboration. I encourage you to discuss the homework problems with your classmates. However, each student must submit his or her own homework solutions. In particular, you are welcome to discuss any of the problems online on our Google Groups discussion forum.

1. Let \( P = (1, 0), Q = (\frac{3}{2}, \frac{\sqrt{3}}{2}), \) and \( R = (\frac{1}{2}, \frac{\sqrt{3}}{2}) \). Prove that the quadrangle with vertices \( O, P, Q, \) and \( R \) is a rhombus. Then prove, using vectors, that \( \overrightarrow{PR} \) is orthogonal to \( \overrightarrow{OQ} \).

2. Find the two unit vectors which are tangent to the circle \( x^2 + y^2 = 1 \) at the point \( P = (\frac{1}{2}, \frac{\sqrt{3}}{2}) \). Then show that \( \overrightarrow{OP} \) is orthogonal to both of these unit vectors.

3. Suppose that \( \vec{v} \) and \( \vec{w} \) are vectors in \( \mathbb{R}^2 \) and that
\[
|\vec{v}| + |\vec{w}| = |\vec{v} + \vec{w}|.
\]
What can you conclude about \( \vec{v} \) and \( \vec{w} \)? Explain your reasoning?

4. Suppose that \( P = (1, 1, 0), Q = (0, 1, 1), \) and \( R = (1, 0, 1) \).
   (a) Find the area of \( \triangle PQR \).
   (b) Find the volume of the parallelepiped spanned by \( O, P, Q, \) and \( R \). (Hint: Look in section 9.4: Cross Products.)
   (c) Find the unit vector which is normal to the plane containing \( \triangle PQR \) and which points into the positive octant of \( \mathbb{R}^3 \).