1. Let \( \mathbf{u} = \langle 1, -2, 0 \rangle \) and \( \mathbf{v} = \langle 2, 2, 1 \rangle \). Then calculate the following quantities:
   (a) \( \mathbf{u} \cdot \mathbf{v} \)
   (b) \( \mathbf{u} \times \mathbf{v} \)
   (c) \( \mathbf{v} \times \mathbf{u} \)
   (d) \( \text{proj}_{\mathbf{u}} \mathbf{v} \) (the projection of \( \mathbf{v} \) onto \( \mathbf{u} \)).

2. Prove that for any three vectors \( \mathbf{u}, \mathbf{v}, \mathbf{w} \in \mathbb{R}^3 \),
   \[
   \mathbf{u} \times \mathbf{v} \times \mathbf{w} = (\mathbf{u} \cdot \mathbf{w})\mathbf{v} - (\mathbf{v} \cdot \mathbf{w})\mathbf{u}
   \]

3. Consider the following picture, where \( \mathbf{n}, \mathbf{l}, \) and \( \mathbf{r} \) are all unit vectors. Give an equation for \( \mathbf{r} \) in terms of \( \mathbf{n} \) and \( \mathbf{l} \) (i.e., that does not refer to \( \theta \)).

4. Consider the plane that contains the points \( \langle 1, 0, 0 \rangle \), \( \langle 0, 1, 0 \rangle \), and \( \langle 0, 0, 1 \rangle \).
   (a) Give the implicit equation for this plane.
   (b) Give the parametric equation for this plane.
   (c) What is the normal vector to this plane?

5. Let \( \mathbf{u}, \mathbf{v}, \mathbf{w} \in \mathbb{R}^3 \) and let \( \mathbf{M} \) be the matrix formed by taking \( \mathbf{u}, \mathbf{v}, \) and \( \mathbf{w} \) as its columns. Then show that
   \[
   \det \mathbf{M} = (\mathbf{u} \times \mathbf{v}) \cdot \mathbf{w}
   \]