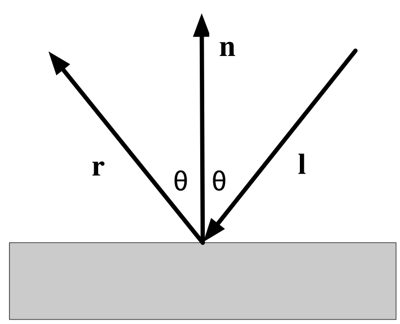
CMSC 23700 | **Introduction to Computer Graphics** | **Homework 1**
Fall 2003 | | **Due October 12**

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) $\mathrm{proj}_{\mathbf{u}}\,\mathbf{v}$ (the projection of $\mathbf{v}$ onto $\mathbf{u}$).

2. Prove that for any three vectors $\mathbf{u}, \mathbf{v}, \mathbf{w} \in \Re^3$,

$$\mathbf{u} \times \mathbf{v} \times \mathbf{w} = (\mathbf{u} \cdot \mathbf{w})\mathbf{v} - (\mathbf{v} \cdot \mathbf{w})\mathbf{u}$$

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 θ).



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 $\mathbf{u}, \mathbf{v}, \mathbf{w} \in \Re^3$ and let $\mathbf{M}$ be the matrix formed by taking $\mathbf{u}$, $\mathbf{v}$, and $\mathbf{w}$ as its columns. Then show that

$$\det \mathbf{M} = (\mathbf{u} \times \mathbf{v}) \cdot \mathbf{w}$$