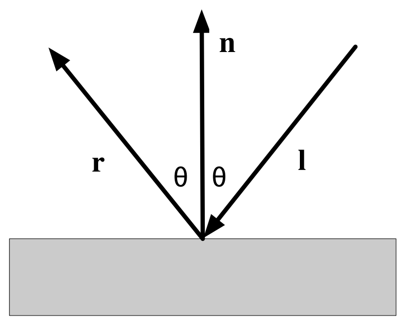
CMSC 23700	**Introduction to Computer Graphics**	**Homework 1**
Winter 2008		**Due January 17**

1. 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).



2. 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

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

3. Affine transformations can be represented by 4×4 homogeneous matrices with the following shape:

$$\begin{bmatrix} \mathbf{M} & \mathbf{t} \\ \mathbf{0} & 1 \end{bmatrix}$$

where $\mathbf{M}$ is a 3×3 matrix and $\mathbf{t}$ is a vector. We can use $\langle \mathbf{M} \mid \mathbf{t} \rangle$ as a more compact notation for this class of matrices. The product of two homogeneous matrices is

$$\langle \mathbf{M}_1 \mid \mathbf{t}_1 \rangle \langle \mathbf{M}_2 \mid \mathbf{t}_2 \rangle = \langle \mathbf{M}_1 \mathbf{M}_2 \mid \mathbf{M}_1 \mathbf{t}_2 + \mathbf{t}_1 \rangle$$

and applying the transformation to a homogeneous point is

$$\langle \mathbf{M} \mid \mathbf{t} \rangle \begin{bmatrix} \mathbf{v} \\ 1 \end{bmatrix} = \mathbf{M}_1 \mathbf{v} + \mathbf{t}$$

If we restrict ourselves to isotropic (uniform) scaling, rotation, and translation, then these matrices are called *SRT* transforms and have the form $\langle s\mathbf{R} \mid \mathbf{t} \rangle$, where s is a scalar and $\mathbf{R}$ is a rotation matrix. Given this notation, solve the following equations:

(a) $\langle s_1 \mathbf{R}_1 \mid \mathbf{t}_1 \rangle \langle s_2 \mathbf{R}_2 \mid \mathbf{t}_2 \rangle$

(b) $\langle s\mathbf{R} \mid \mathbf{t} \rangle \begin{bmatrix} \mathbf{v} \\ 1 \end{bmatrix}$

(c) $\langle s\mathbf{R} \mid \mathbf{t} \rangle^{-1}$