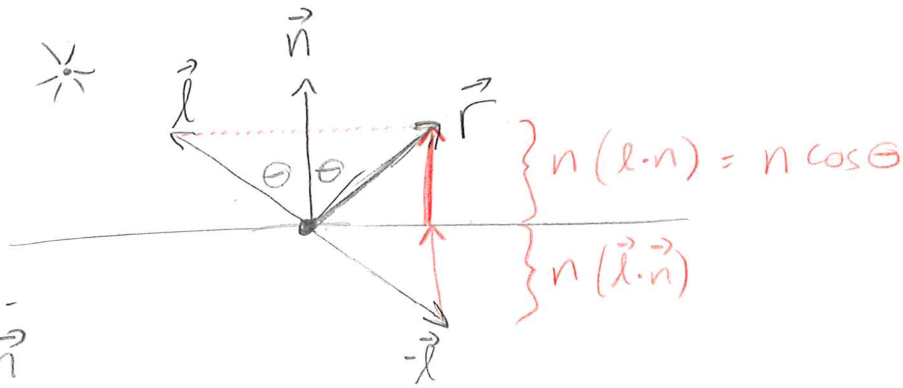
Shiny Surfaces

Specular: 

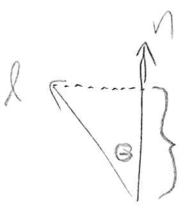
Mirror:



Light reflected in only one direction - reflected across $\vec{n}$

What direction is $\vec{r}$?

Dot product $\vec{l} \cdot \vec{n}$ gives length of projection of $\vec{l}$ onto $\vec{n}$ ($= \cos\theta$)

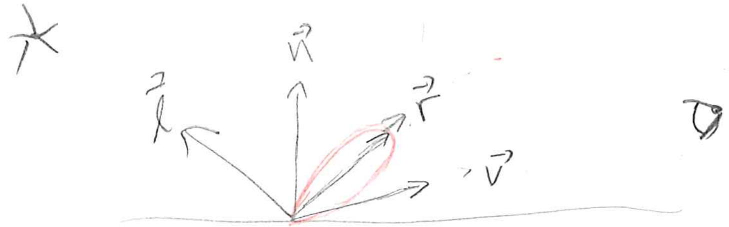


$\vec{l} \cdot \vec{n} = \cos\theta$ (scalar)

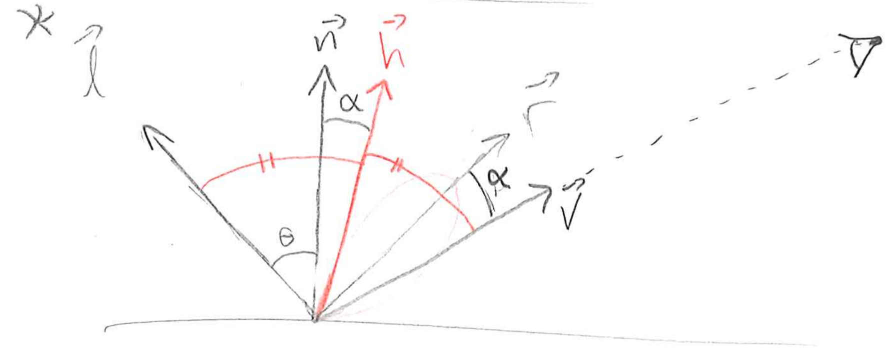
This quantity times $\vec{n}$ gives the vector from the (flat) surface to $\vec{r}$'s endpoint. To get $\vec{r}$, take $-\vec{l}$ and add 2x this vector: $\boxed{\vec{r} = \vec{l} + 2(\vec{l} \cdot \vec{n})n.}$

Shiny but not mirror:

Brighter (reflects more light) near "mirror" configuration.



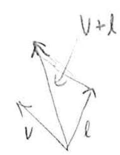
Specular Reflection:



More light near mirror configuration ($\vec{v} = \vec{r}$)

Phong — Intuitive heuristic: $L_s = f(\vec{r} \cdot \vec{v}) = f(\cos \alpha)$

Blinn-Phong — Alternative: $h \leftarrow \text{bisector}(\vec{v}, \vec{l})$ "half-vector" $\vec{h} = \frac{\vec{v}+\vec{l}}{\|\vec{v}+\vec{l}\|}$



$$L_s = f(\vec{n} \cdot \vec{h})$$

Not always equivalent in 3D; Blinn-Phong is closer to reality, and faster to compute.

In both cases, $f(x) = k_s \max(0, x)^p$

k_s: "Strength" of Specularity

p: "sharpness" of Specularity

Blinn-Phong model, complete: $L_s = I \, k_s \max(0, \vec{n} \cdot \vec{h})^p$

I: light intensity

k_s: specular coefficient (Strength and color of shininess)

$\vec{n}$: normal

$\vec{h}$: half-vector between $\vec{l}$ and $\vec{v}$

p: specular exponent; "sharpness" of specularity

Most surfaces are a mix of diffuse and specular, so the full shading model is $L = L_d + L_s$

L_d: diffuse reflection

L_s: specular reflection