OpenGL's Implementation of the Phong Local Lighting Model
At a Point, *P*, on a Surface

$$I = E + k_a * L_a + \sum_{i=0}^{n-1} f_{att;i} s_i \left\{ \left[k_d * \left(\hat{\mathbf{n}} \cdot \hat{\mathbf{l}}_i \right) L_{d;i} \right] + \left[k_s * \left(\hat{\mathbf{r}}_i \cdot \hat{\mathbf{v}} \right)^m L_{s;i} \right] \right\}$$

where

$$f_{att;i} = \begin{cases} 1 & if \left(\text{directional ("infinitely far away") light: } (x,y,z,0) \right) \\ \dfrac{1}{k_0 + k_1 d + k_2 d^2} & if \left(\text{light source placed at a specific point: } (x,y,z,1) \right) \end{cases}$$

$$d = \text{distance}\left(Light_i, P \right)$$

$$s_i = SpotlightAttenuation \text{ (GL\_SPOT\_DIRECTION, GL\_SPOT\_EXPONENT, GL\_SPOT\_CUTOFF)}$$

RED: glMaterial*

BLUE: glLight* (Assumes *n* lights defined and enabled.)

CYAN (only L_a): glLight* and glLightModel*.

DARK GREEN (only $\hat{\mathbf{r}}_i$): $\hat{\mathbf{n}}$ & glLight* & maybe *P*.

GREEN: glLight* & *P*.

MAGENTA (only $\hat{\mathbf{v}}$): either a constant or *f*(*P*,viewer_position).

$\hat{\mathbf{n}}$ is the assumed normal to the surface at *P* and is set by glNormal*.