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Q1. Ambient Reflection
Diffuse Reflection a, b
Specular Reflection a, b, c

Q2. In Phong Illumination,
specifically, the specular reflection $\sum_{i=1}^{s} k_i I_i \cos^n \phi$
if you increase the parameter n, you will get the effect

Q3. (a) $k_d = 0.6$ $I_s = 1$
Lighting Vector $\vec{L} = \frac{(10-1, 10-10, 1-1)}{9} = (1, 0, 0)$
Normal Vector $\vec{N} = \frac{(1, 0, 1)}{\sqrt{2}} = (\frac{\sqrt{2}}{2}, 0, \frac{\sqrt{2}}{2})$
the diffuse reflection is $k_d \cdot I_s \cdot (N \cdot L)$
$0.6 \times 1 \times \frac{\sqrt{2}}{2} = \frac{3\sqrt{2}}{10}$

(b) Lighting vector $\vec{L} = \frac{(10-x, 0, 1-z)}{\sqrt{(10-x)^2+(1-z)^2}}$

since $x+z-2=0 \Rightarrow x = 2-z$

$$\vec{L} = \frac{(8+z, 0, 1-z)}{\sqrt{(8+z)^2+(1-z)^2}} = \frac{(8+z, 0, 1-z)}{\sqrt{2z^2+14z+65}}$$

then we have $\frac{\sqrt{2}}{2} = \frac{\frac{\sqrt{2}}{2} \cdot 8+z + \frac{\sqrt{2}}{2} \cdot (1-z)}{\sqrt{2z^2+14z+65}}$

$$\Rightarrow 1 = \frac{8+z+1-z}{\sqrt{2z^2+14z+65}}$$

$\Rightarrow 81 = 2z^2+14z+65 \Rightarrow z^2+7z-8=0 \Rightarrow (z-1)(z+8)=0 \Rightarrow z=8$
thus another $(-6, 10, 8)$ has the same diffuse reflection

Q4. $k_a = 0.1$ $k_d = 0.7$ $k_s = 0.2$ $n = 2$ $I_s = 1$ $I_a = 1$

observer $(20, 0, 0)$

point light $(8, 10, 10)$

object $(0, 0, 0)$

the point is $(2, 0, 0)$

① ambient reflection $= I_a \cdot k_a = 0.1$

lighting vector $\vec{L} = (\frac{3}{\sqrt{59}}, \frac{5}{\sqrt{59}}, \frac{5}{\sqrt{59}})$ normal vector $\vec{N} = (1, 0, 0)$

② diffuse reflection $= k_d \cdot I_s \cdot (\vec{N} \cdot \vec{L}) = 0.7 \times 1 \times \frac{3}{\sqrt{59}} = 0.7 \times \frac{3}{\sqrt{59}} \approx 0.273$

viewing vector $\vec{V} = (1, 0, 0)$

reflected vector $\vec{R} = 2 \cdot (\vec{N} \cdot \vec{L}) \cdot (\vec{N} - \vec{L})$

$\vec{V} \cdot \vec{R} = 1 \cdot 2 \cdot (\frac{3}{\sqrt{59}}) \cdot (1 - \frac{3}{\sqrt{59}}) = \frac{6}{\sqrt{59}} - \frac{18}{59}$

③ specular reflection $= I_s \cdot k_s \cdot (\vec{V} \cdot \vec{R})^n$

$= 1 \times 0.2 \times (\frac{6}{\sqrt{59}} - \frac{18}{59})^2 \approx 0.045$

The sum is $0.1 + 0.273 + 0.045 = 0.418$