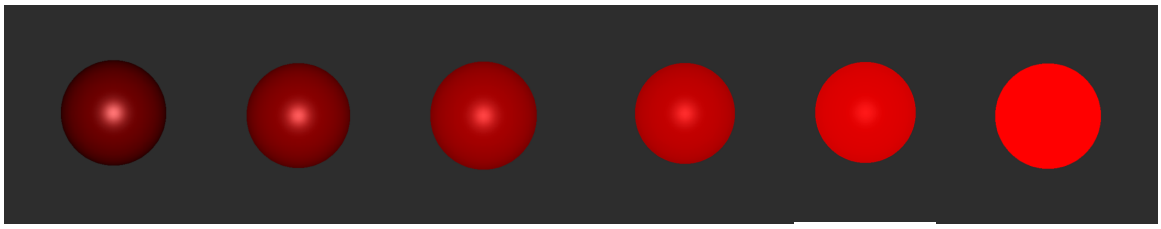
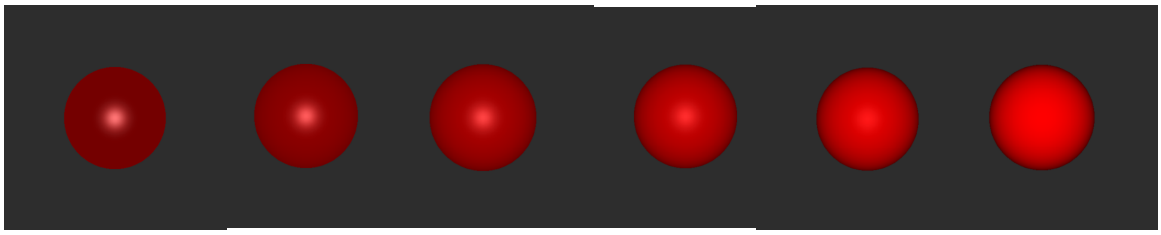
1. A demonstration and discussion of how the values of k_a, k_d, k_s, n, and $O_{s\lambda}$ can be varied to simulate qualitatively different material types and a discussion of what sorts of materials cannot be well represented by the Blinn-Phong model

The Blinn-Phong model excels at representing shiny, single-colored materials. The parameters can be tweaked in many ways to make objects look like metals and plastics. It cannot represent translucent materials, and struggles to represent multicolored objects, objects that reflect on themselves, and surfaces with texture (though a finely detailed enough scene can do this).

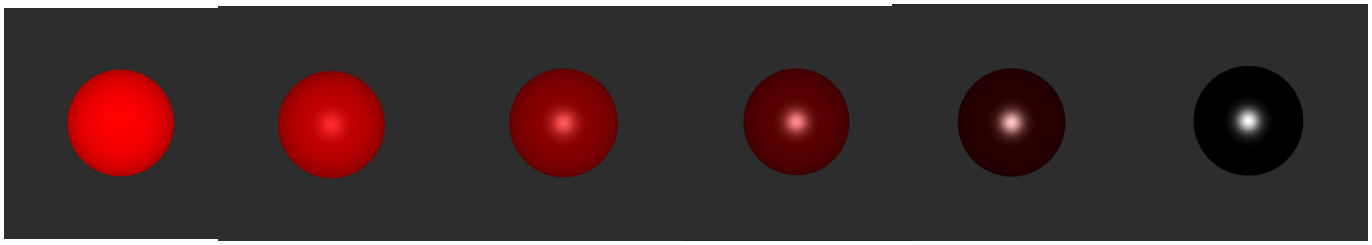
Modifying k_a changes the amount of ambient light present to the object. A proportionally high k_a causes objects to be well-illuminated at every pixel while a proportionally low k_a causes objects to only be visible at pixels that are reflecting light specularly. Lower k_a values also make objects look rounder, while high values make them appear flat, since there is less variation in color. The below images are arranged in order of increasing k_a proportions:



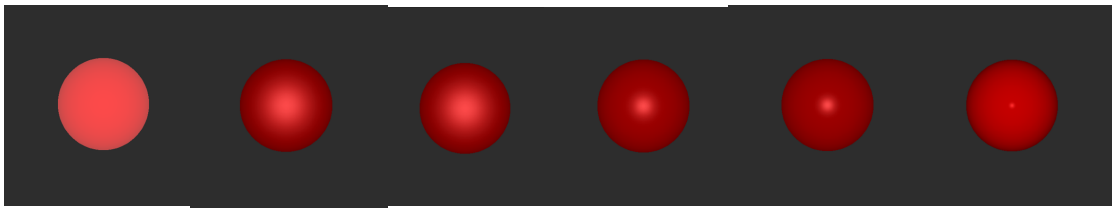
Modifying k_d changes the amount of diffuse reflection by the object. Diffuse reflection is visible from angles up to 180 degrees from the surface and makes objects appear rounder the higher its value. From my experimentations it seems to be the most important factor in creating a rounded appearance; it affects all visible pixels in the object not just the ones that reflect right at the eye. The below images are arranged in order of increasing k_d proportions:



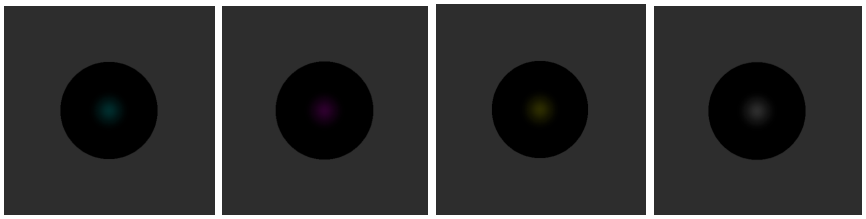
Modifying k_s changes the amount of specular reflection by the object. Specular reflection is visible from angles equally far from but across the surface's normal direction from the light source. Higher values make objects appear smoother since smooth objects are shiny. The below images are arranged in order of increasing k_s proportions:



Modifying n changes the rate at which specular reflection decreases as the difference between the eye's angle and the light's relative to the surface's normal direction increases. It makes reflections appear smaller the higher the value. The below images are arranged in order of increasing n:



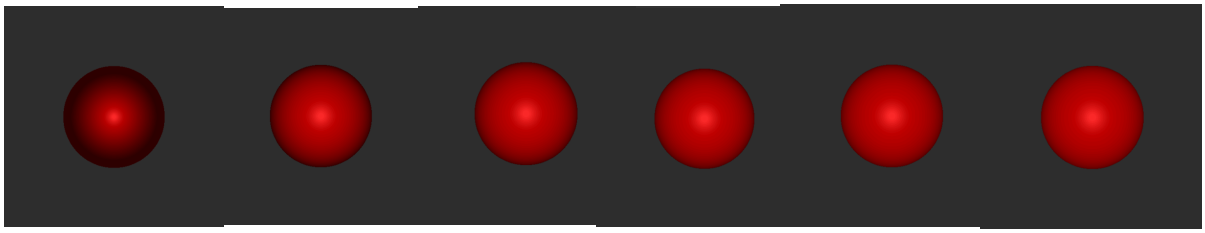
Modifying $O_{s\lambda}$ changes the color of the specular reflection. The below images show various specular reflection colors on a black sphere:



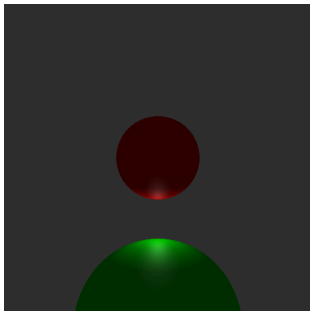
2. A demonstration and discussion of the fundamental characteristics of how a scene's appearance can differ when a point light source vs a directional light source is used.

Point light sources generate rays of light radially around themselves; this means that the diffuse component of the Blinn-Phong model is stronger for point light sources when they are further away from the object they're illuminating. The specular reflections are also larger when the point light source is further away from the object, as the angle of the rays hitting the object further away from the exact surface normal is much larger A point light source extremely far from the object is indistinguishable from a directional light source as the rays hitting the object are almost parallel. A point light source can also be between objects, causing asymmetrical lighting. Lastly, the shadow cast by an object illuminated by a point light source can change in size as the light source gets closer to and further away from the object.

The below images are arranged in order of increasing point light source distance from the object; specular reflection size decreases and diffuse reflection strength increases as distance increases. The last image is a parallel light source; note that it is indistinguishable from the second last image with a point light source at a distance of 50



The below image (example6 in the handout) demonstrates asymmetric lighting by a point light:



The below images (example5 from the handout and a modified version) demonstrate a changing shadow size as a result of a point light's distance from the closest object changing: