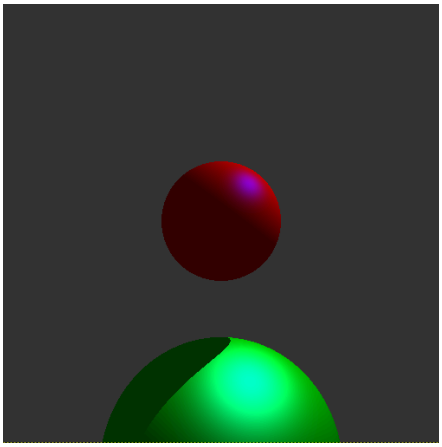
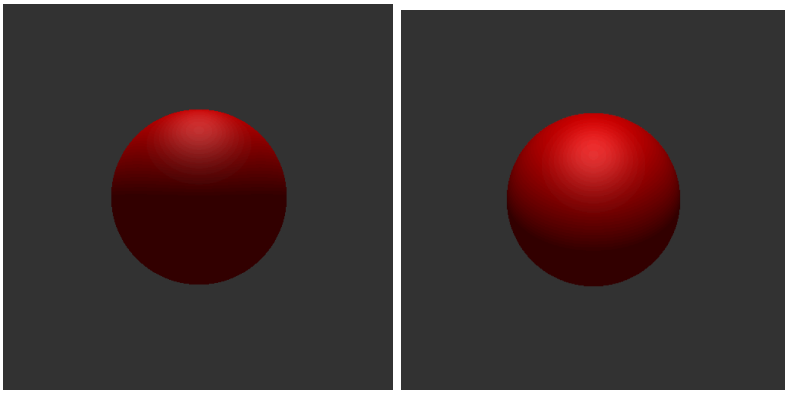
Impacts of the terms:

Increasing *ka* increases the ambient term and makes for a more intense color. Similarly, *kd* impacts the diffuse term, which causes a flatter color when its value is lower. Changing *ks* makes the material seem more reflective, which is helpful for metallic materials. The exponent *i* decreases the size of the specular highlight as its value increases. *Os lambda* affects the color of the specular highlight and can be utilized to make objects appear to be made of different materials, such as plastic or metal. *Od lambda* relates to the "actual" color of the object—the color it would have without any lighting or shadows. It provides a base color for the object. Both spheres in the image below have a ks of 0.8 to increase the intensity of the highlights. The red sphere has an Os lambda of 0 0 1 for the blue highlight, while the green sphere has one of 0 1 1 to give a greenish-blue highlight.



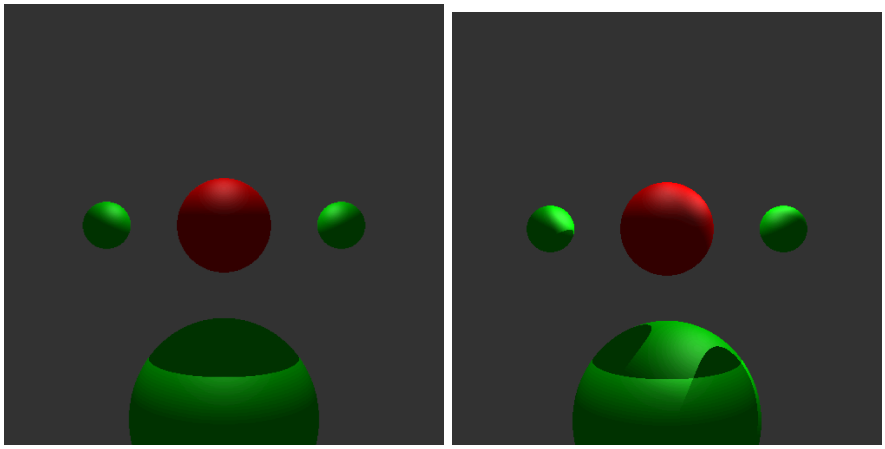
Directional light vs point light:

When a directional light is implemented, the direction to the light from any given point is constant. In contrast, the direction to a point light from any given point on the shape is different. A sphere lit by a directional light will have a straighter line between the lit area and non-lit area than one lit by a point light, which will have a more curved line. In the pictures below, the one on the left is lit by directional light and the one on the right is lit by a point light. In this example, the point light shows the dimensions of the sphere better.



Multiple lights vs a single light:

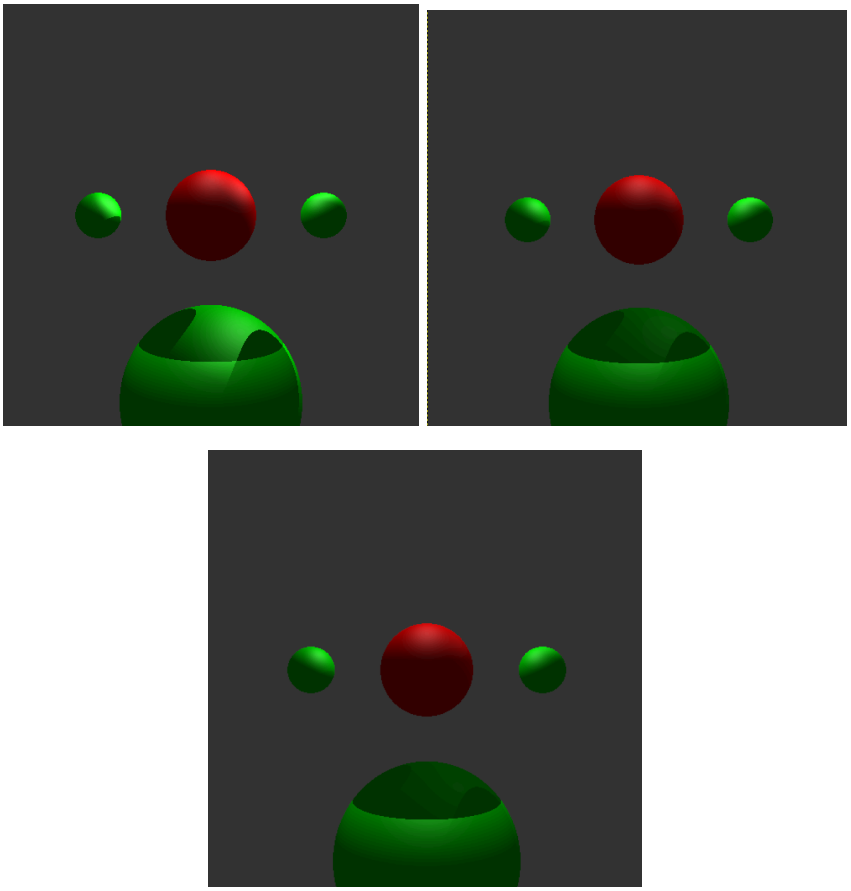
Adding multiple lights means that light is hitting the sphere from multiple directions, which can be accomplished by using a for loop to sum up the diffuse and specular terms for each individual light. It is important to keep the intensity of each light less than 1, in order to not overload the operations. The image on the left is with a single light, while the image on the right has two lights—one from the top and one from the right and slightly behind.



Extra credit:

Light attenuation:

I implemented light attenuation, which allows the light to fall off with distance. In the example below, the first image is without attenuation, the second one only has a value for c2, and the third only has a value for c3. This demonstrates the impact of multiplying by d^2 instead of d, which causes the light attenuation to fall off more quickly.



Depth cueing:

I also implemented depth cueing. In the image on the left, the depth cue color is the same as the background color, which makes the edges of the sphere appear blurry. In the picture on the right, I changed the color to blue to make the effect more visible. It also creates a neat glowing effect.