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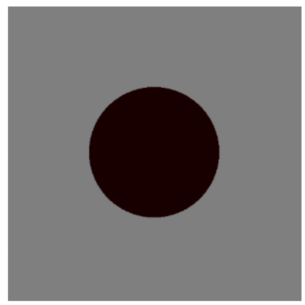
Assignment 1b

CSCI5607

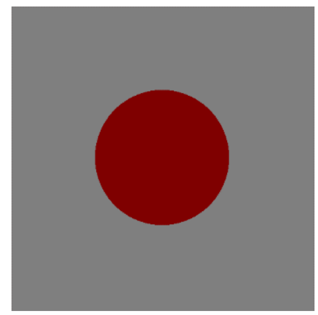
In this new iteration of the Ray Tracer, a few new capabilities were added. The scene description has some extra work to do—now, many different lights can be defined, materials have more properties, and some actual ray tracing is done in the ShadeRay function that calculates lighting and shadow.

A material is now specified by its diffuse color, a specular color, and the coefficients *ka, kd, ks,* and exponent *n*. The diffuse color provides both the color for the actual object without any lights, and for when it is lit up.

Here, just a single red sphere is rendered, but noticeably darker than the spheres rendered in the first assignment, even though a light exists in this scene. This sphere's diffuse color is red, but its diffuse coefficient is 0—as such, the only colors scene are those being ambiently provided. If the ambient coefficient is increased a bit, then this sphere gets a bit brighter.



ka=0.1

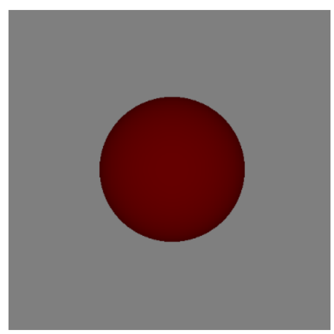


ka=0.5

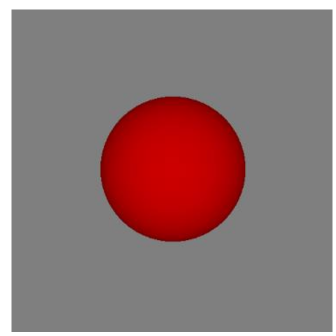
However, that's boring. Let's add some diffuse color to our sphere so we can see the light.

Now, the lighting can be seen. Here the light is pointing straight at the sphere, so there are black shadings towards the edges.

Making the diffuse coefficient higher adds more of the diffuse color to the final color, which means that the effect of shading on the edges will appear to be more pronounced.



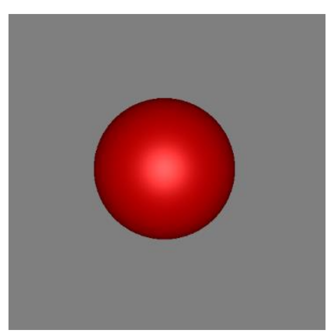
kd = 0.3



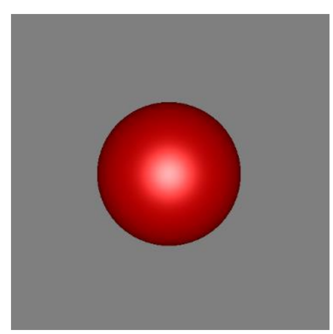
kd = 0.7

Now, we can add a specular highlight that looks like a reflection. The specular coefficient determines how much specular light is added.

This makes the object seem more "reflective" but note that it doesn't really change the focus size of the reflection.

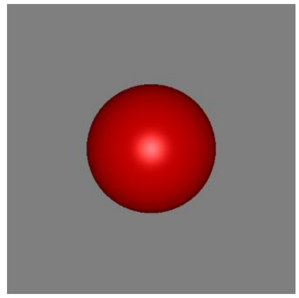


ks = 0.4

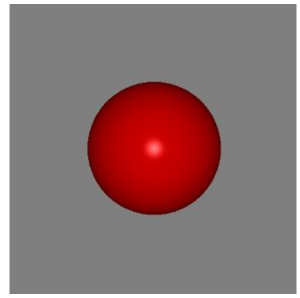


ks = 0.7

To change the size of the reflection of the specular component, we can “focus” it by increasing the specular exponent *n*. In the previous examples, the exponent was set to 20, but by increasing it we can make it seem much more focused.



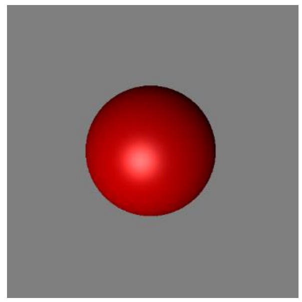
n = 50



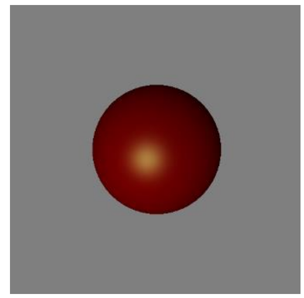
n = 200

Note that all of these play in tangent with the location of the light, the color of the light, and the diffuse and specular colors of the object. Changing the location of the light will make some areas darker and some lighter, and the specular highlight will change. Changing the color of the light means that only certain colors (or certain amounts of colors) are reflected, and changing the color of the object’s specular color means that the specular highlight can only reflect that amount of color. Usually this is just white, but it can be something else.

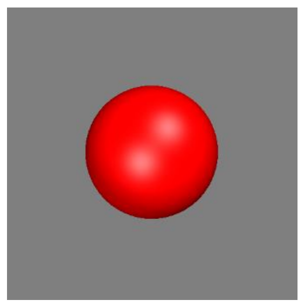
Of course, multiple lights can also be added for more light/more specular reflections and will look as such.



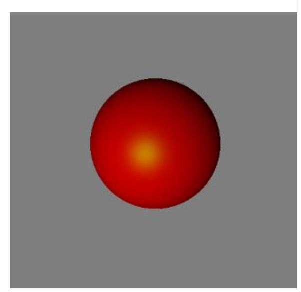
light moved



light's color changed



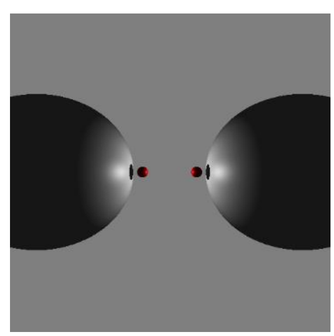
two lights



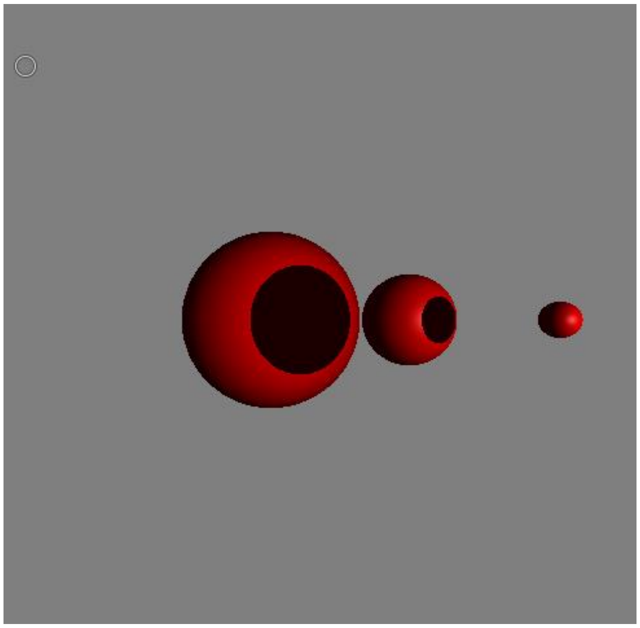
specular only reflects green

Using all of these values in tangent, multiple different materials can be simulated. This works pretty good for lots of matte-looking materials, such as rubber or plastic surfaces, and specular highlights are mostly just white and nothing more. However, the lighting model is much less accurate for very reflective materials, such as metals whose color is almost entirely reflective, or something like mirrors which actually reflect the light from the objects themselves instead of a single color.

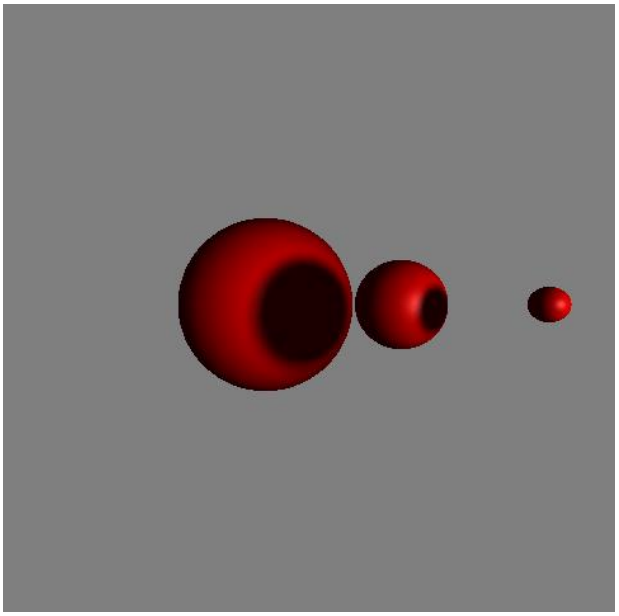
When defining a scene with lights, you must provide a *w* value of 0 or 1 to denote if it is a point light or a directional light. Not everything can be calculated with a directional light—take this example. Here, the light is not seen but it is located in the middle of the scene as a point light. You can see the two specular highlights on the large sphere and the small shadows caused by the little spheres. A directional light clearly couldn’t make these shadows, since the spheres are so large they would cast shadows on each other.



Soft Shadows are also implemented. The softness can be changed in the Ray.cpp file, where you can edit the globals that determine how many rays to sample, and the radius of the ray.

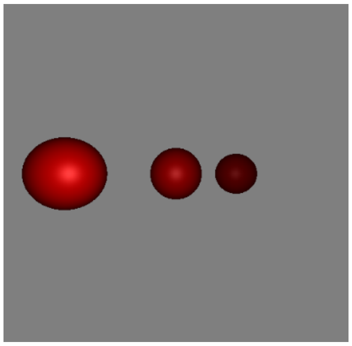


no soft shadows



soft shadows

An attenuated light can also be specified. Here, three spheres are the same size but at different distances from the light (which is located where the camera is). The further objects are darker because the light is attenuated.



Depth cueing is also implemented. Here the light is coming from the side, so none of these spheres are in shadow. The light is a directional light, so this is not coming form attenuation. The last sphere is beyond the maximum depth, and is using a mix of black as the depth cued color. Fade to white works too.