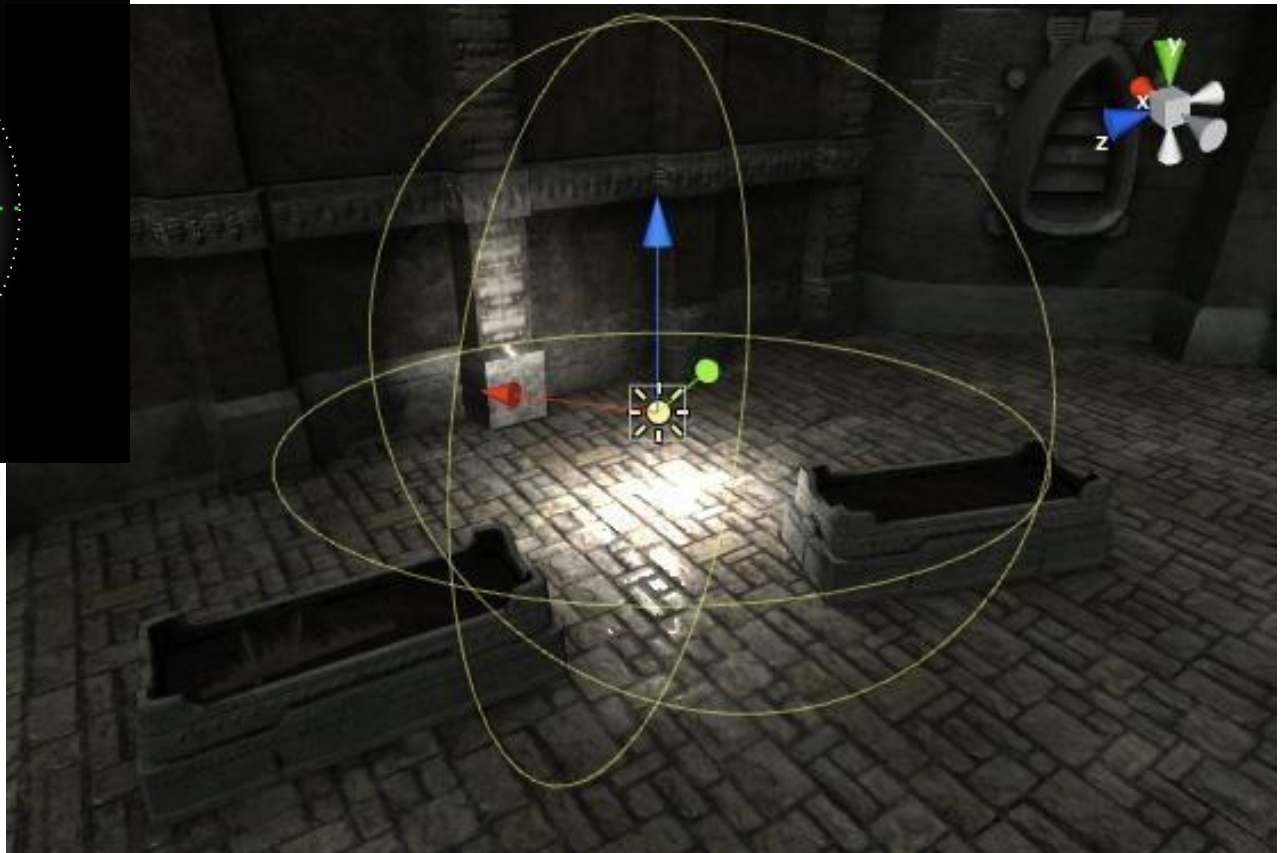
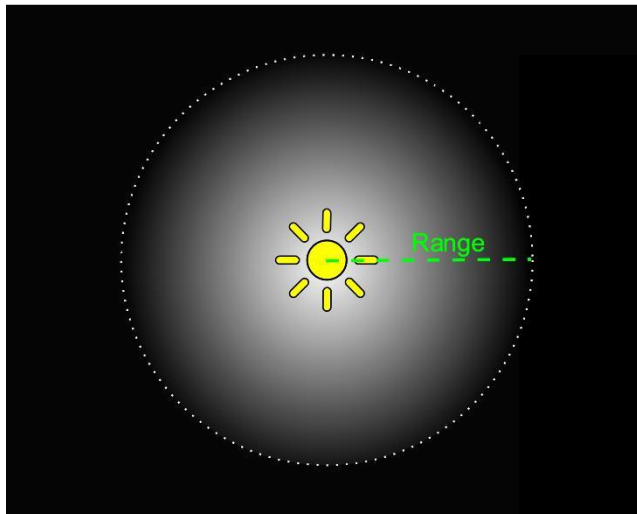

Computer Graphics

- Lighting & Material

Sung Soo Hwang

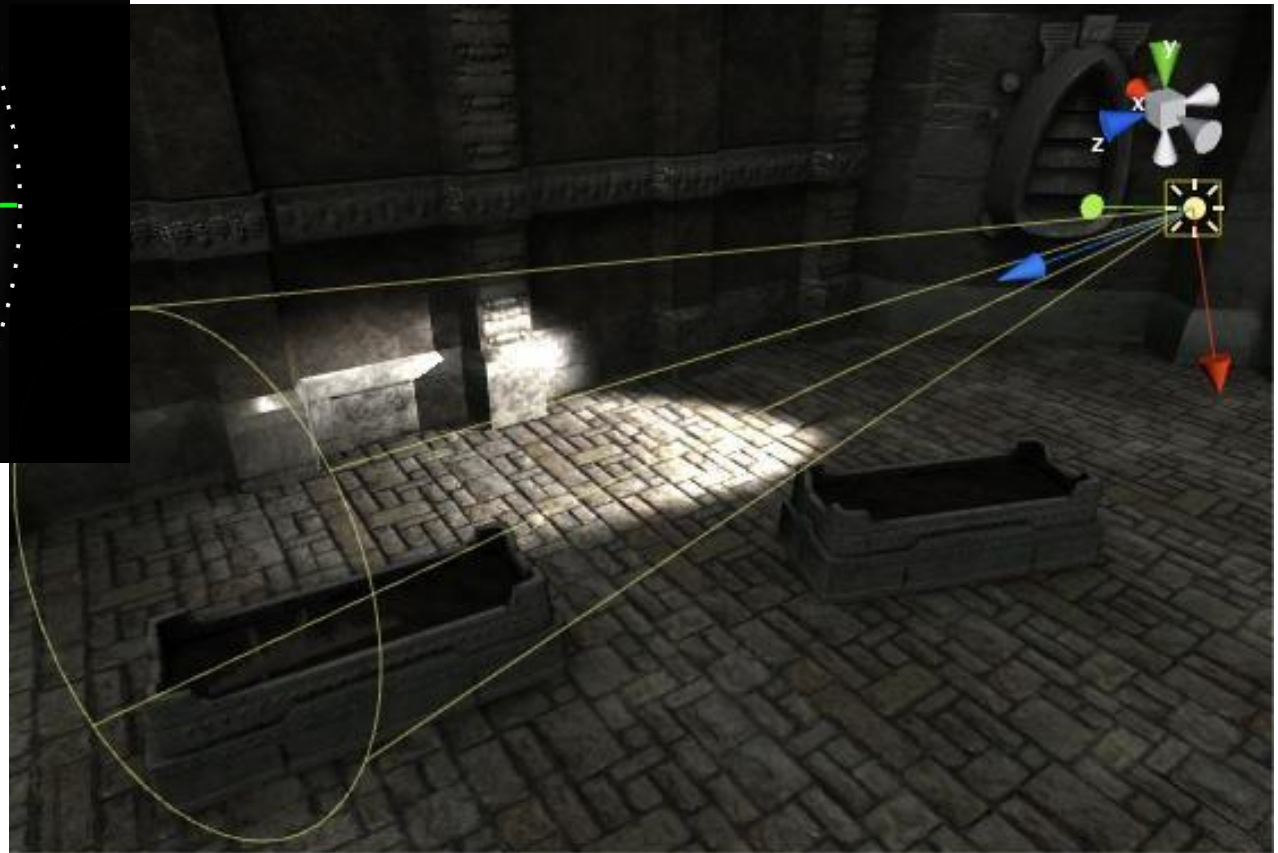
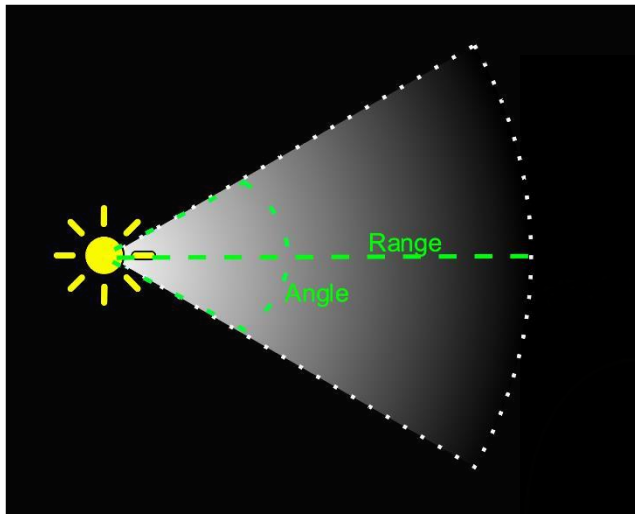
Light sources

- Point light
 - With light rays starting from a single point.



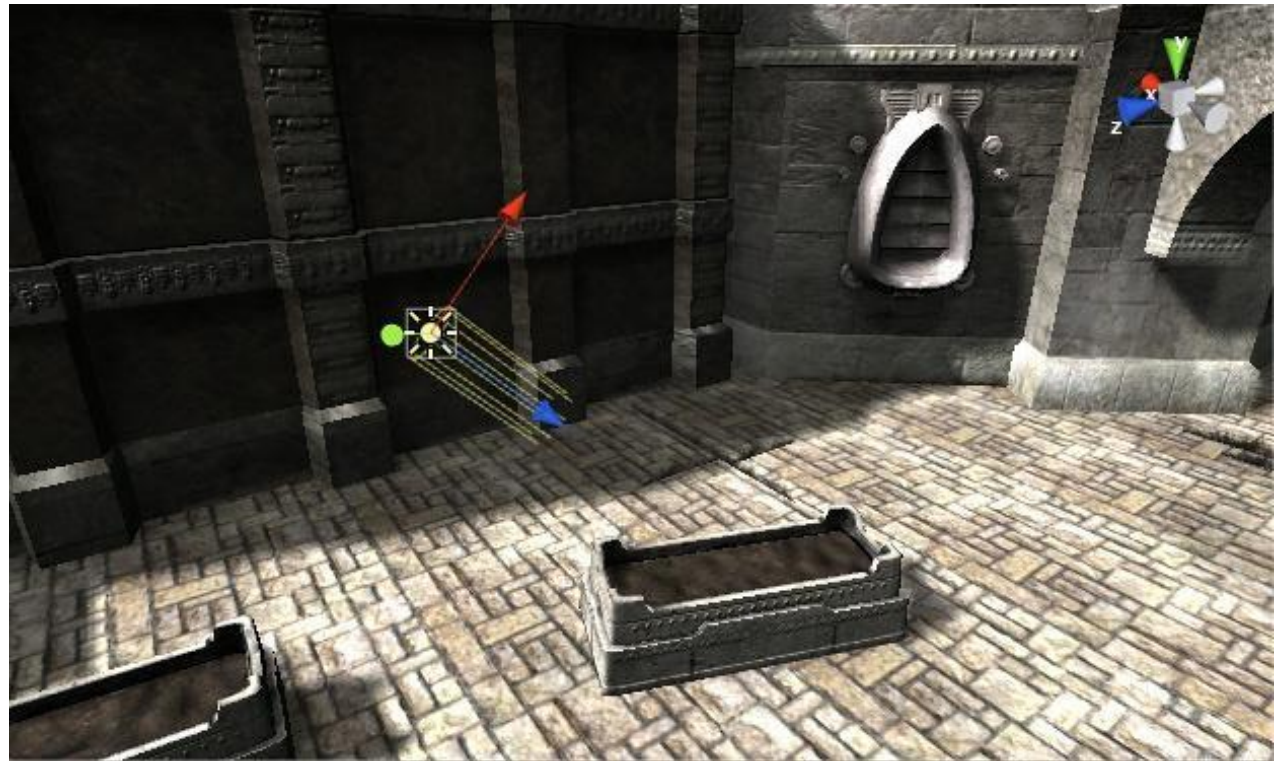
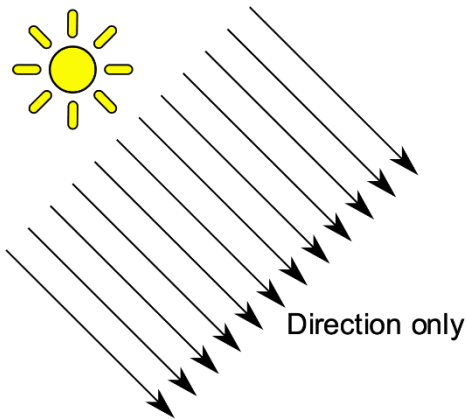
Light sources

- Spot light
 - Distributing light rays within a cone.



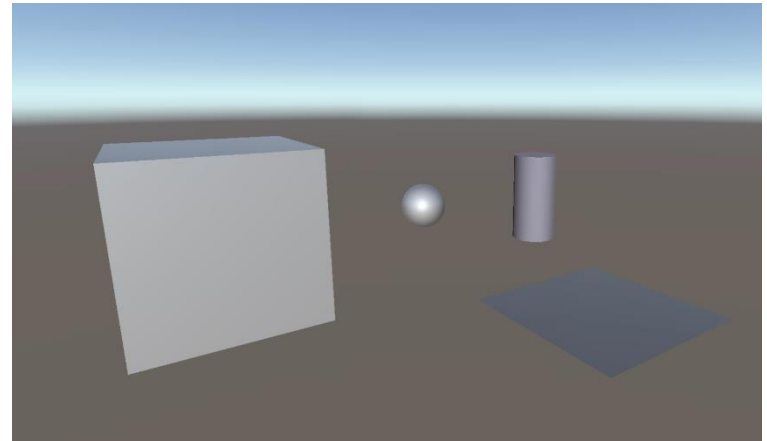
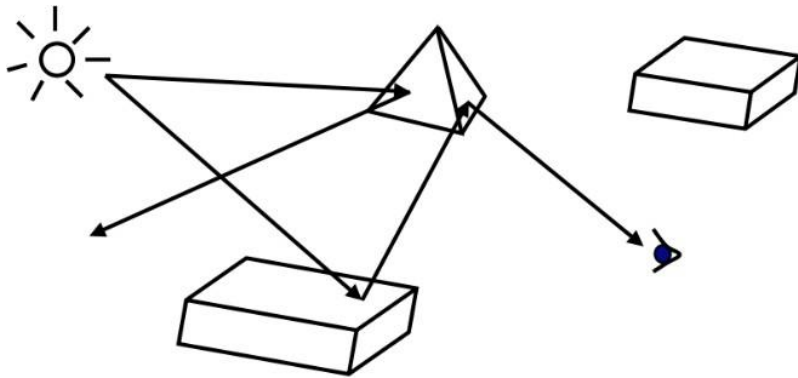
Light sources

- Directional light
 - With parallel light rays, e.g., the sun.



Light sources

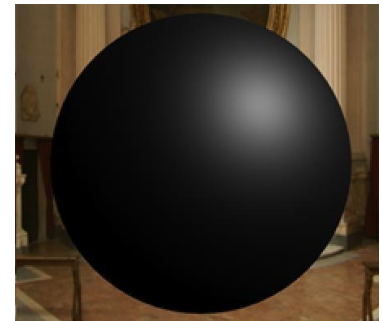
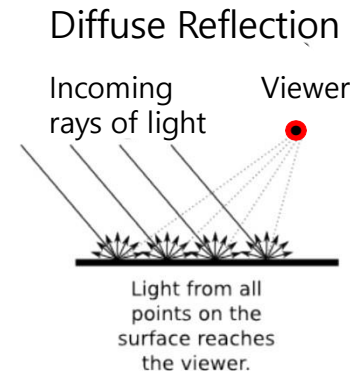
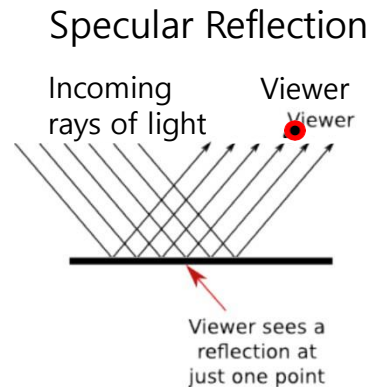
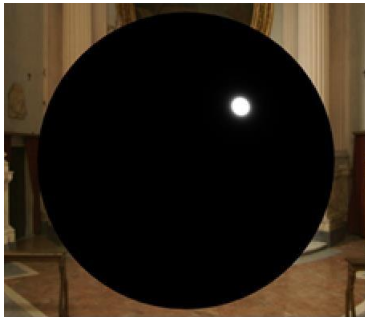
- Ambient light
 - It consists of light that has been reflected so many times that it is no longer coming from any particular direction.
 - Equal intensity at all points in a scene.



Light-material Interactions

- Light-material Interactions

- When light strikes a surface, some of it will be reflected.
- Reflection depends on the material properties of the surface.
- It is commonly approximated by two general types of reflection : specular reflection and diffuse reflection.



- Diffuse Reflection

- It is usually assumed that diffuse reflection is made on a surface called Lambertian reflection, meaning that the surface appears equally bright from all viewing directions.
- Diffuse reflection is produced usually on rough or grainy surfaces like clay, soil, fabric, etc.



Chalk



Fabric



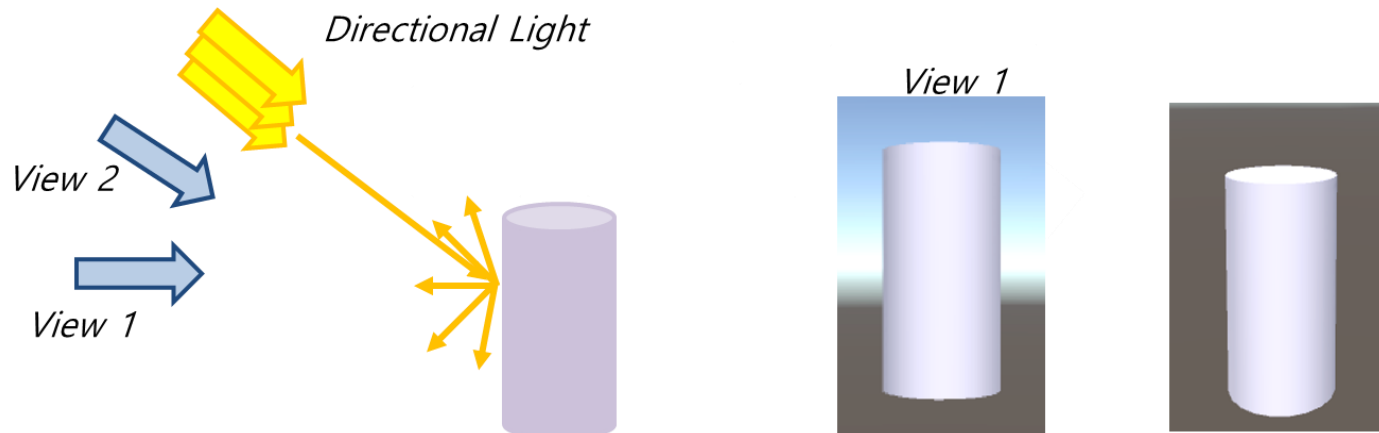
Plaster

- Diffuse Reflection

- The brightness at each point is proportional to $\cos(\theta)$
- This is because a surface (A) perpendicular to the light direction is more illuminated than a surface (B) at an oblique angle.

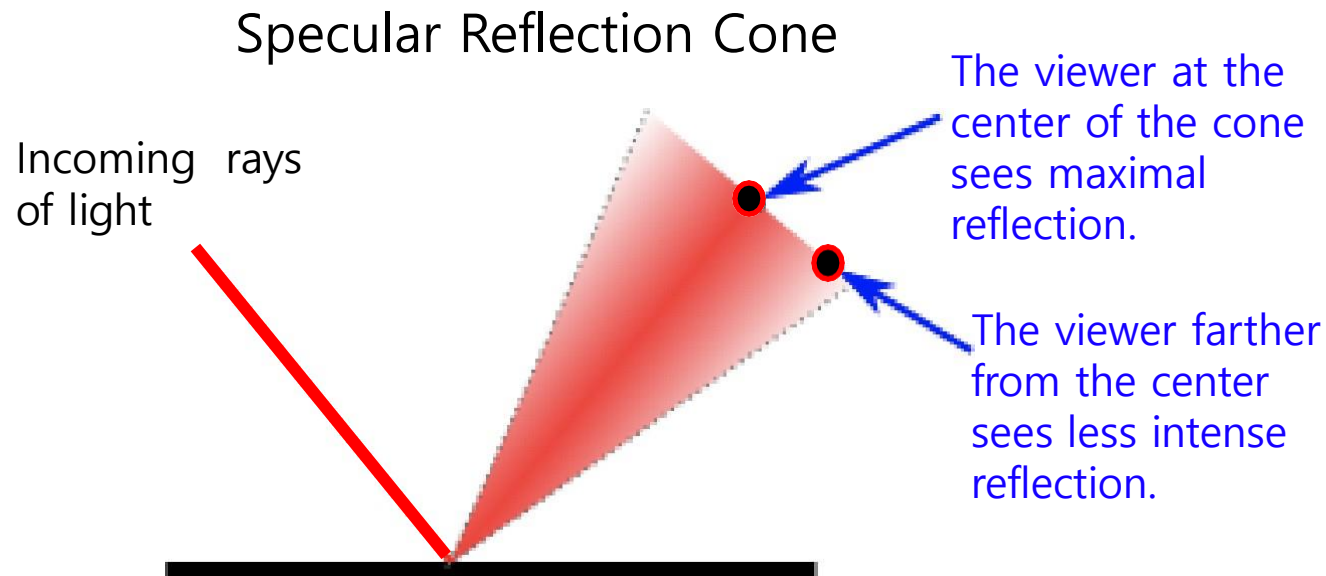


- Diffuse reflection is independent of the position of the viewer, unlike the specular reflection.



- Specular Reflection

- In perfect specular (“mirror-like”) reflection, an incoming ray of light is reflected from the surface intact.
- The reflected ray makes the same angle with the surface as the incoming ray.
- In practice, we think of a ray of light as being reflected not as a single perfect ray, but as a cone of light, which can be more or less narrow.



Light-material Interactions

- Specular Reflection



Still Water



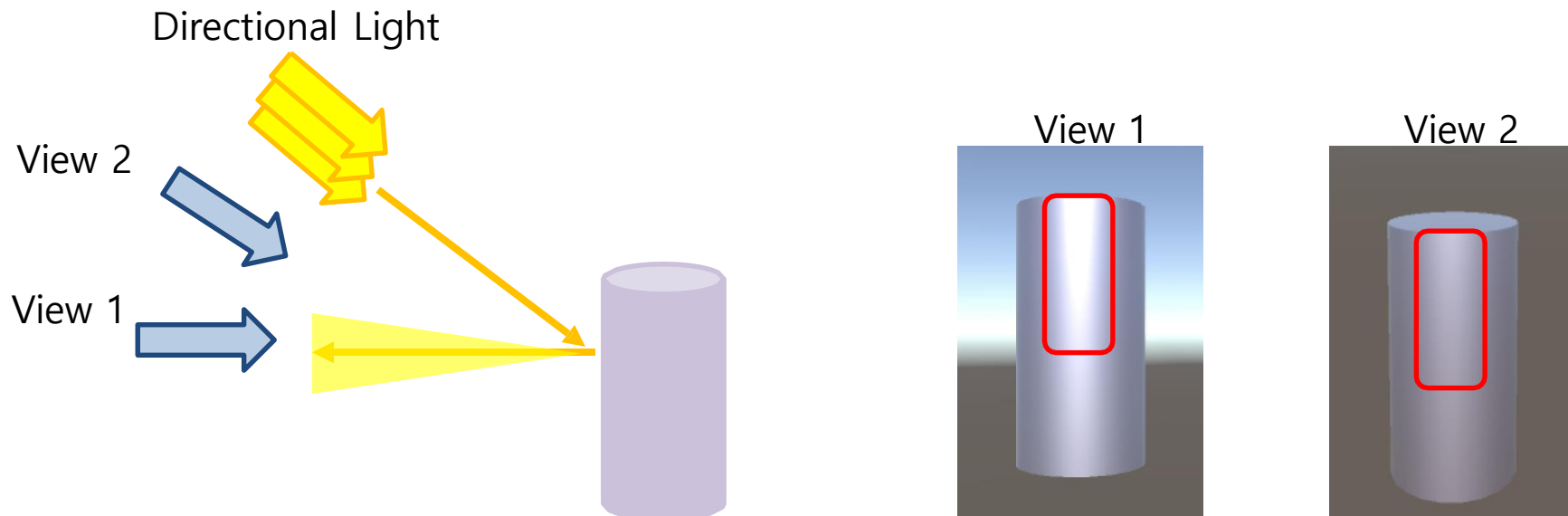
Metal



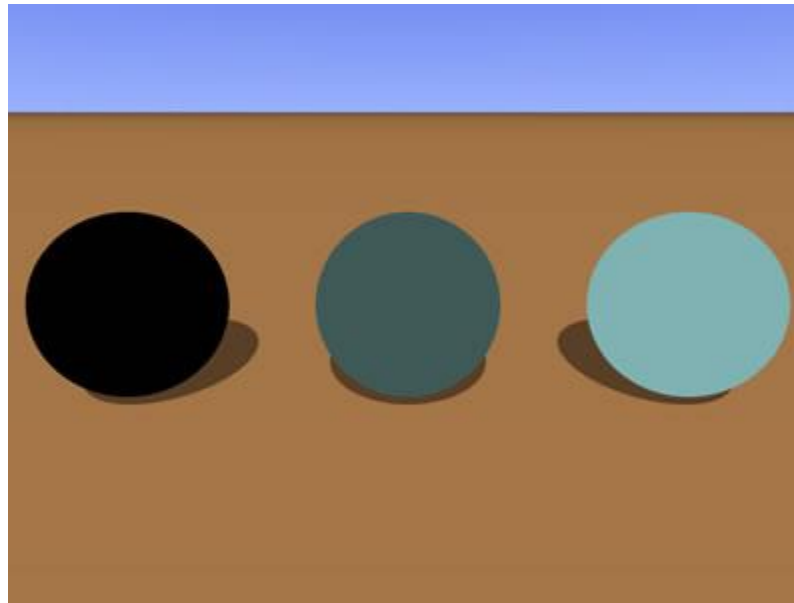
Plastic

- Specular Reflection

- Specular reflection from a very shiny surface produces very narrow cones of reflected light while a duller surface has wider cones of reflected light.
- A viewer can see the specular reflections only if the viewer is exactly in the right cone area. Such reflections are referred to as specular highlights, which are dependent on the position of the viewer as well as the positions of light sources.



- Ambient Reflection
 - It approximately models an average reflection of undirected lights from all light sources.



(From left to right, ambient values of 0.0, 0.5 and 1.0 in a 0 to 1 scale)

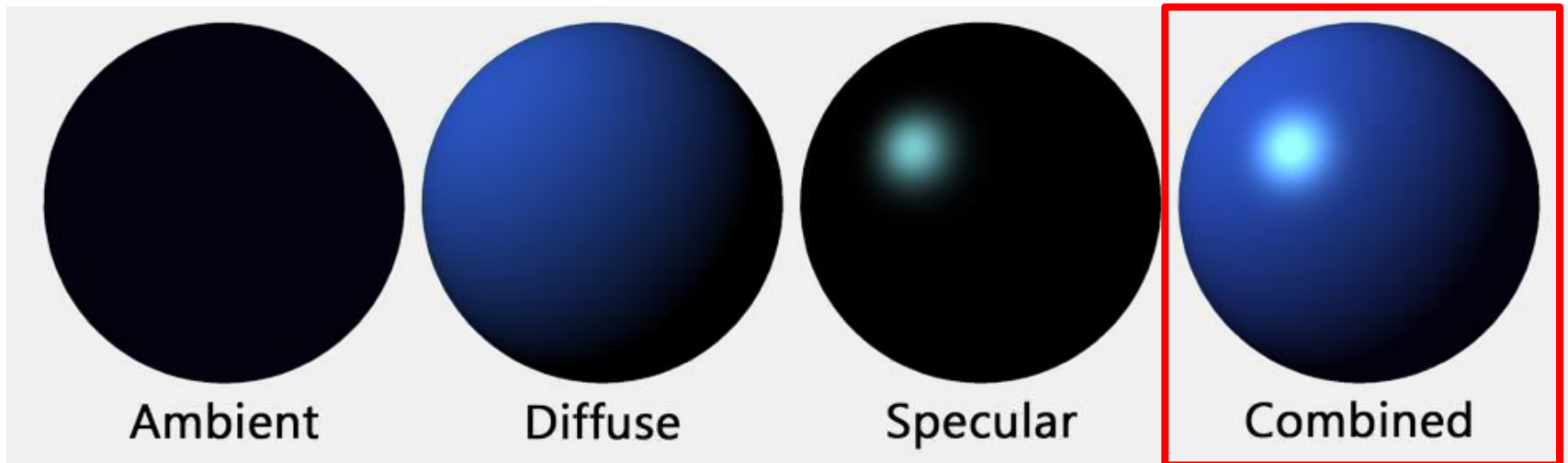
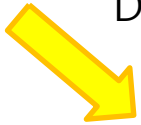
Light-material Interactions

- Phong Reflection Model
 - Efficient approximation of material properties for real-time graphics

$$I_A + I_D + I_S = I$$

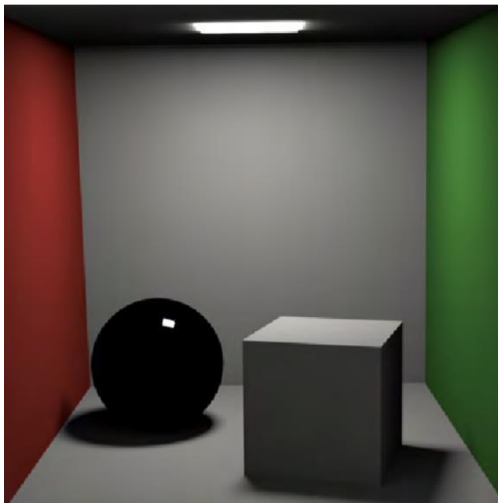
ambient diffuse specular
reflection reflection reflection

Directional Light

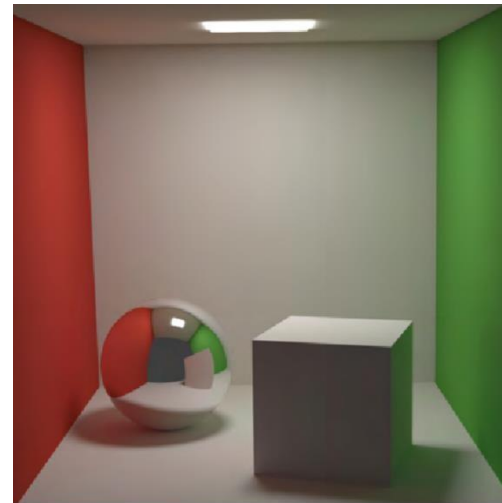


Global vs local Illumination

- Global Illumination
 - Reflected, scattered, and focused light (not discrete).
 - Illumination at a point can depend on any other point in the scene.
- Local Illumination
 - Discrete light source
 - Illumination depends on local objects & light sources only.



Local



Global