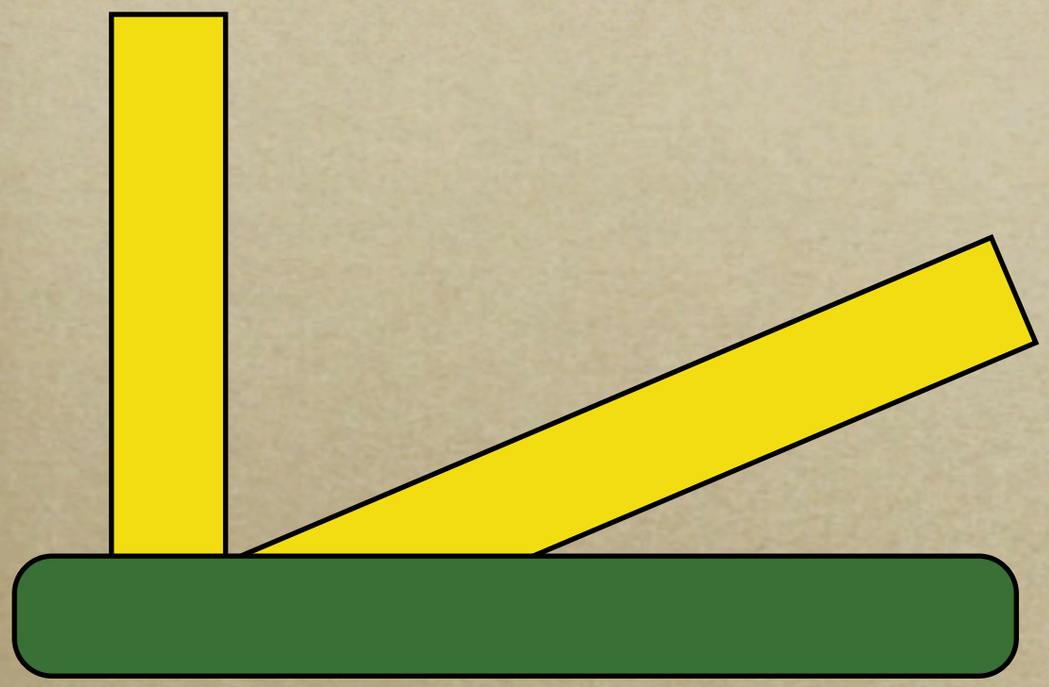
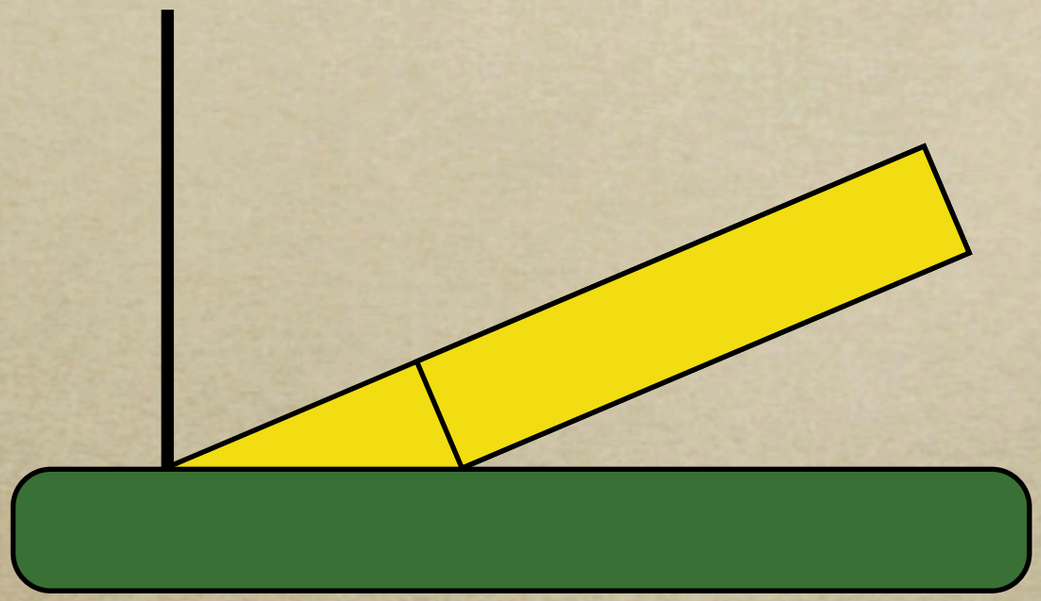
Yet more ray tracing...

Illumination models

Light: where from and where to?

Lambertian/Diffuse Illumination

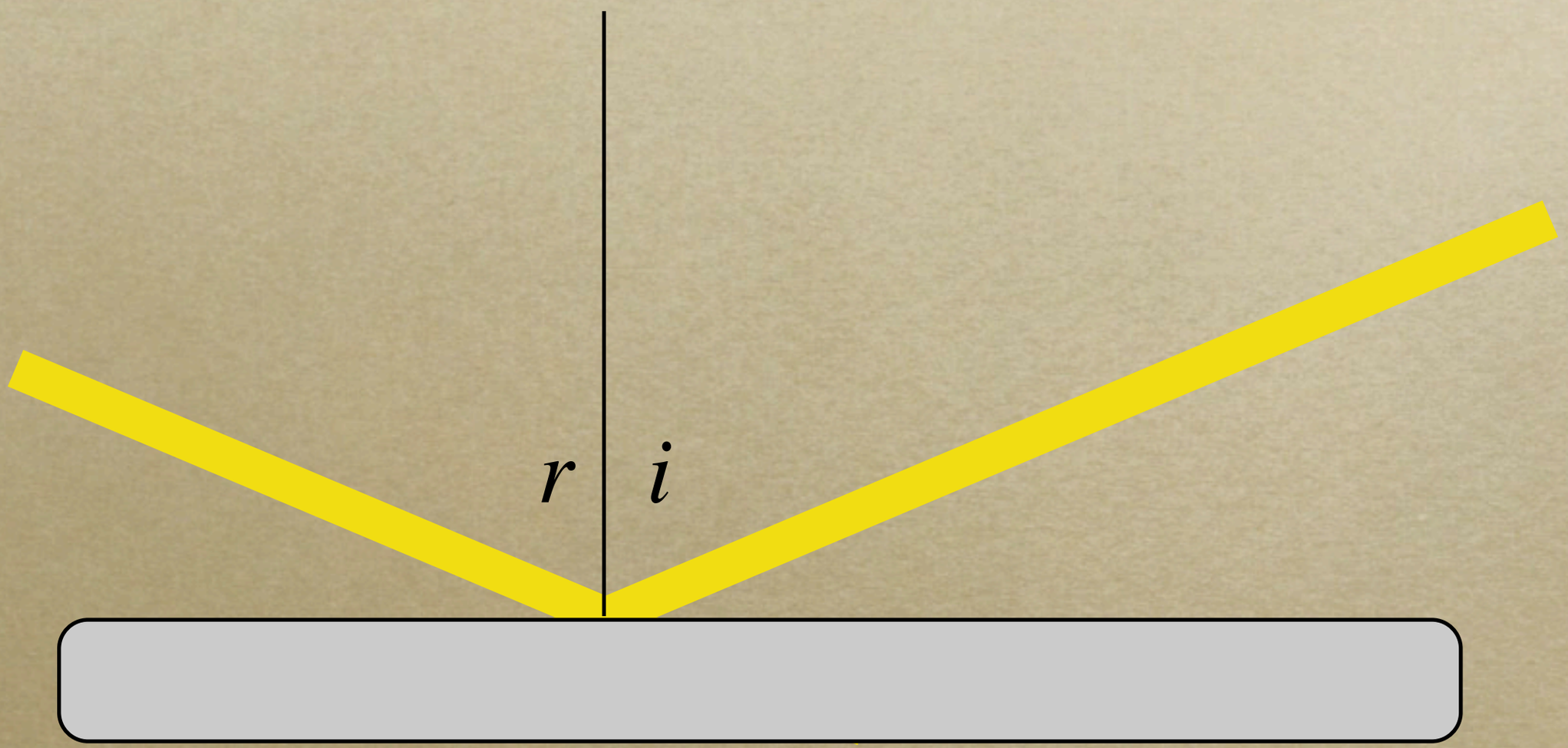




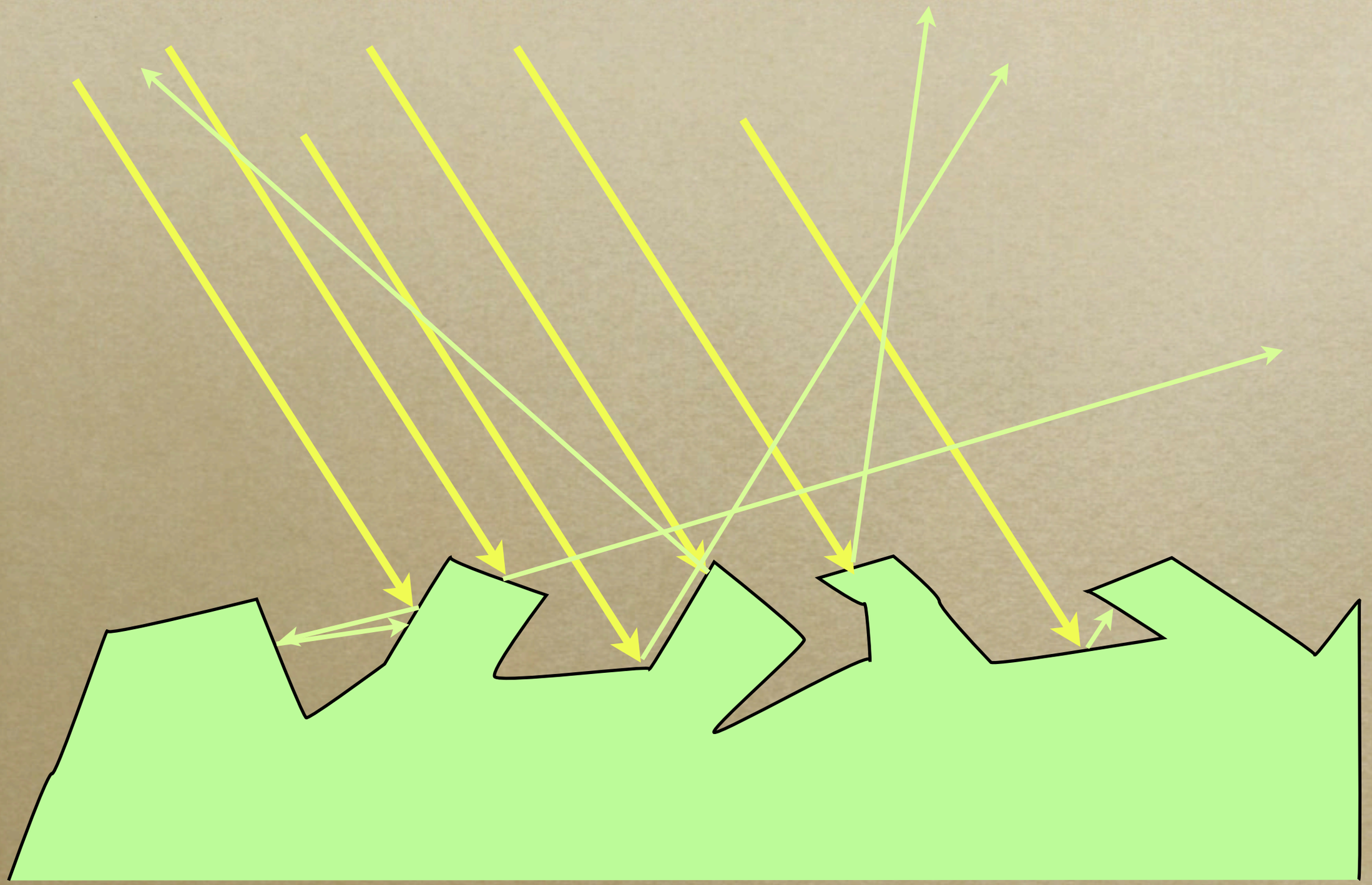
$$I_d = k_d I \boldsymbol{n} \bullet \boldsymbol{i}$$

Mirror reflection

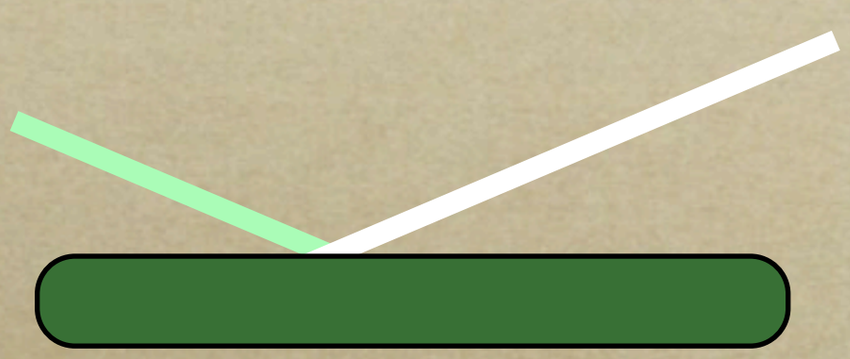
$$i = r$$

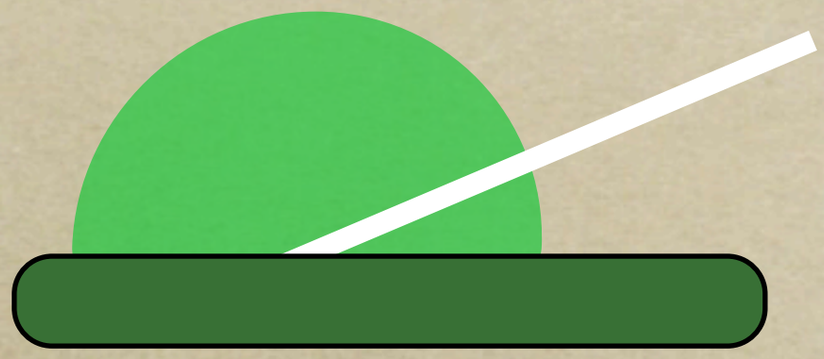


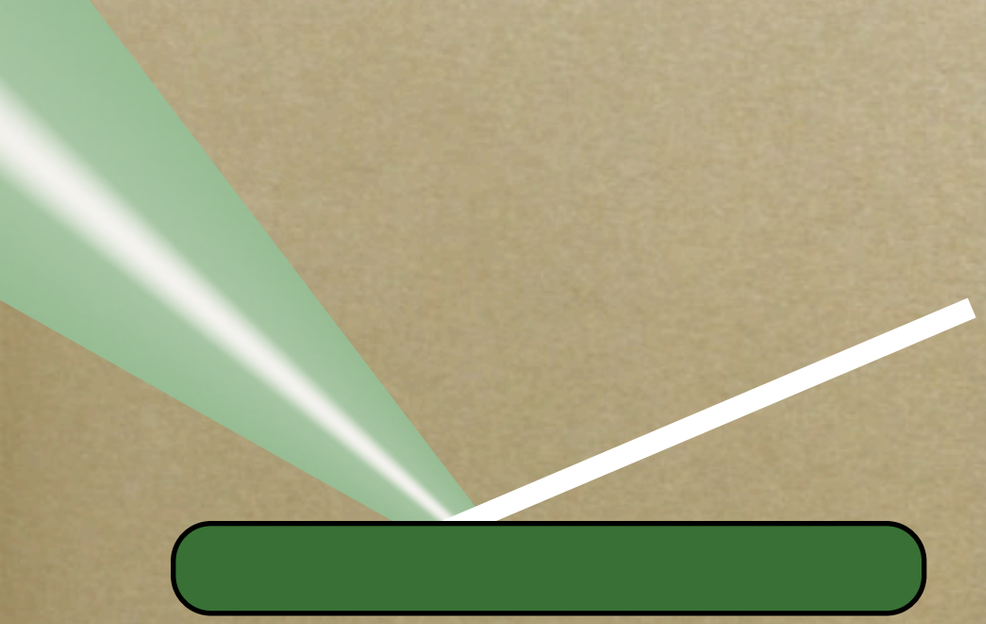
Real surfaces are complicated



Approximate behaviour

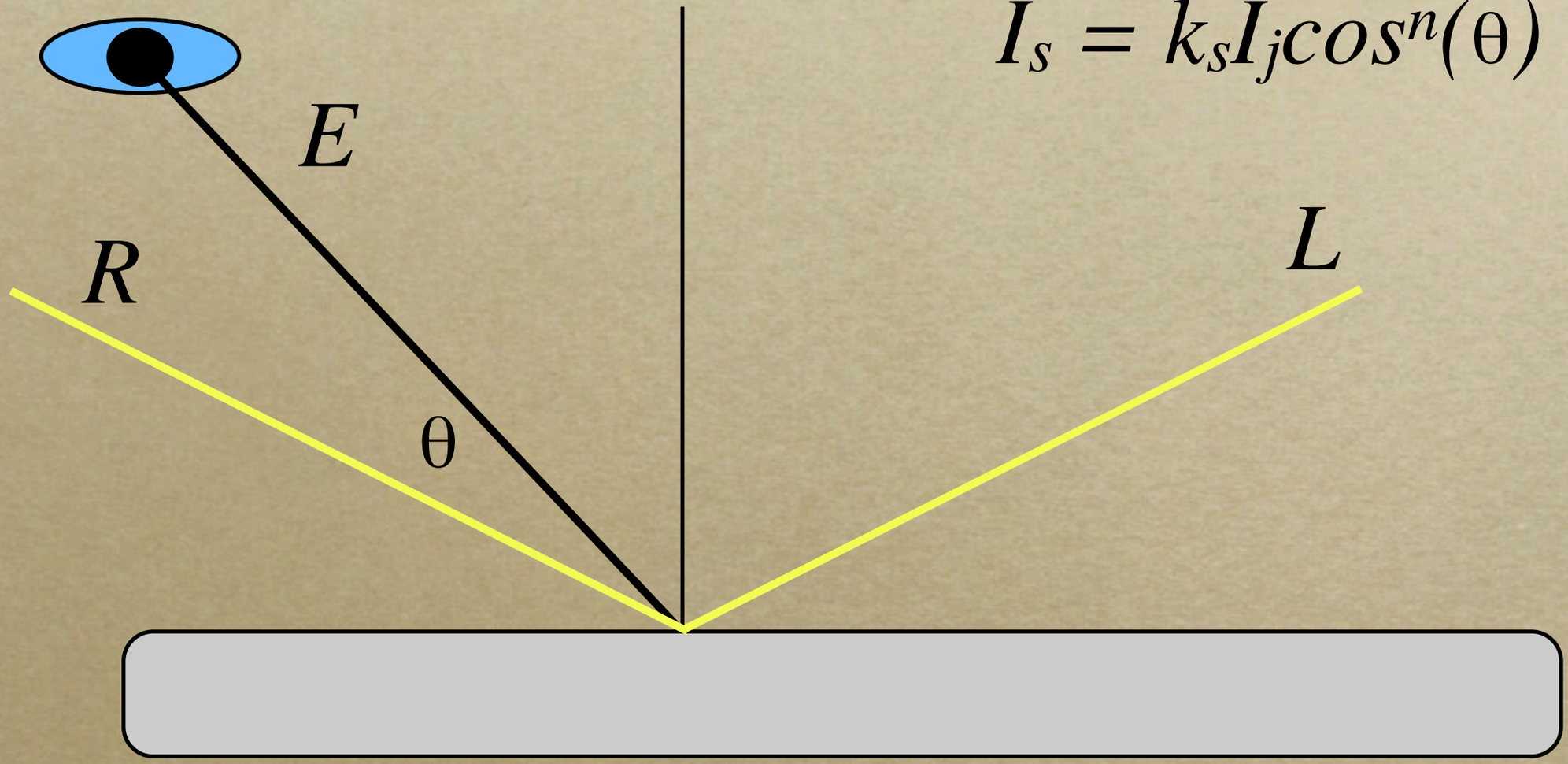






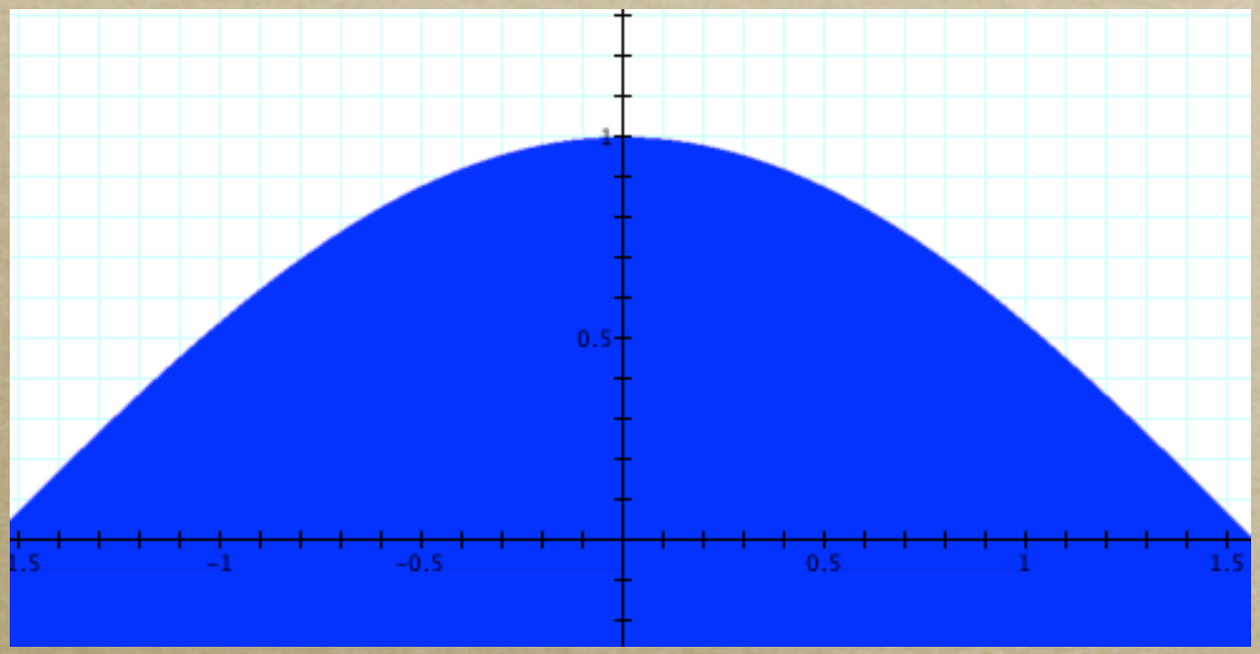
Some reflected
Some diffused
Some in-between

Phong's Model



$$I_s = k_s I_j cos^n(\theta)$$

Why $\cos^n(\theta)$?



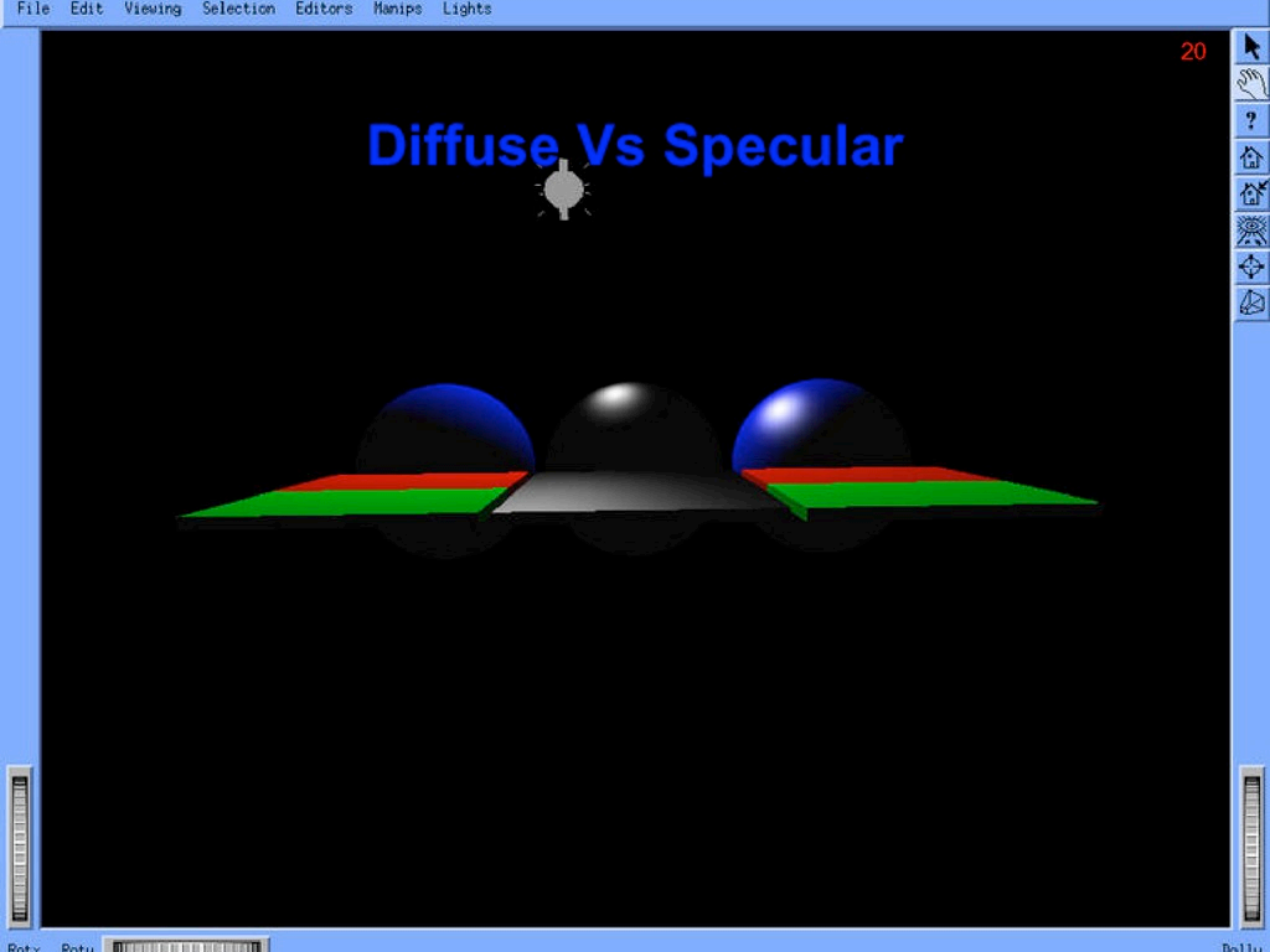
$$n = 1 .. 6500$$

File Edit Viewing Selection Editors Manips Lights

19

Diffuse Vs Specular

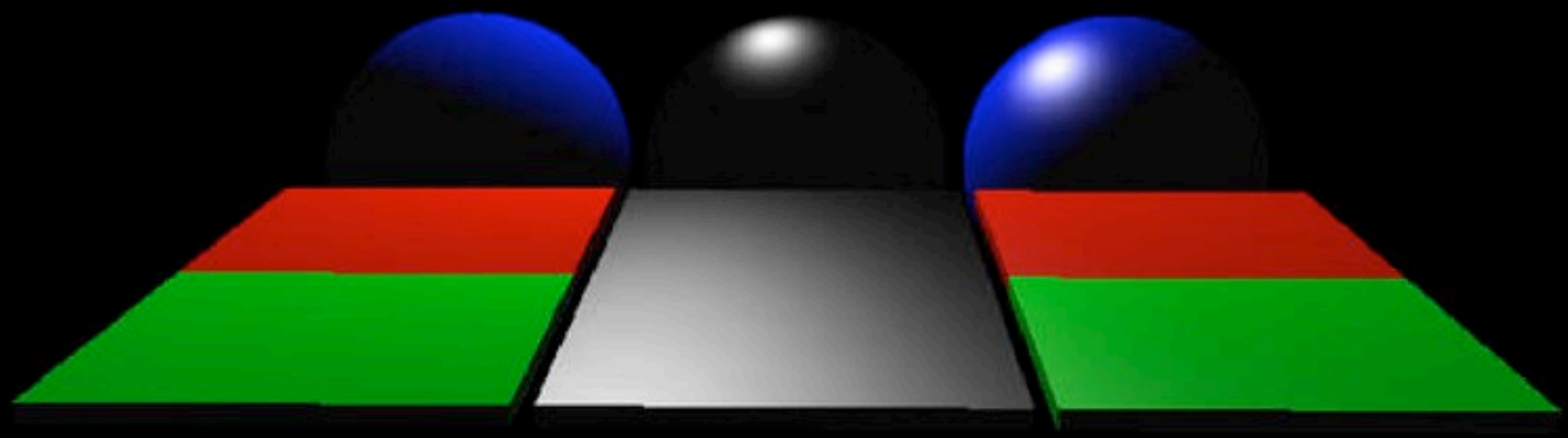
Rotx Roty Pollu


File
Edit
Viewing
Selection
Editors
Manips
Lights
20
Diffuse Vs Specular

File Edit Viewing Selection Editors Manips Lights

21

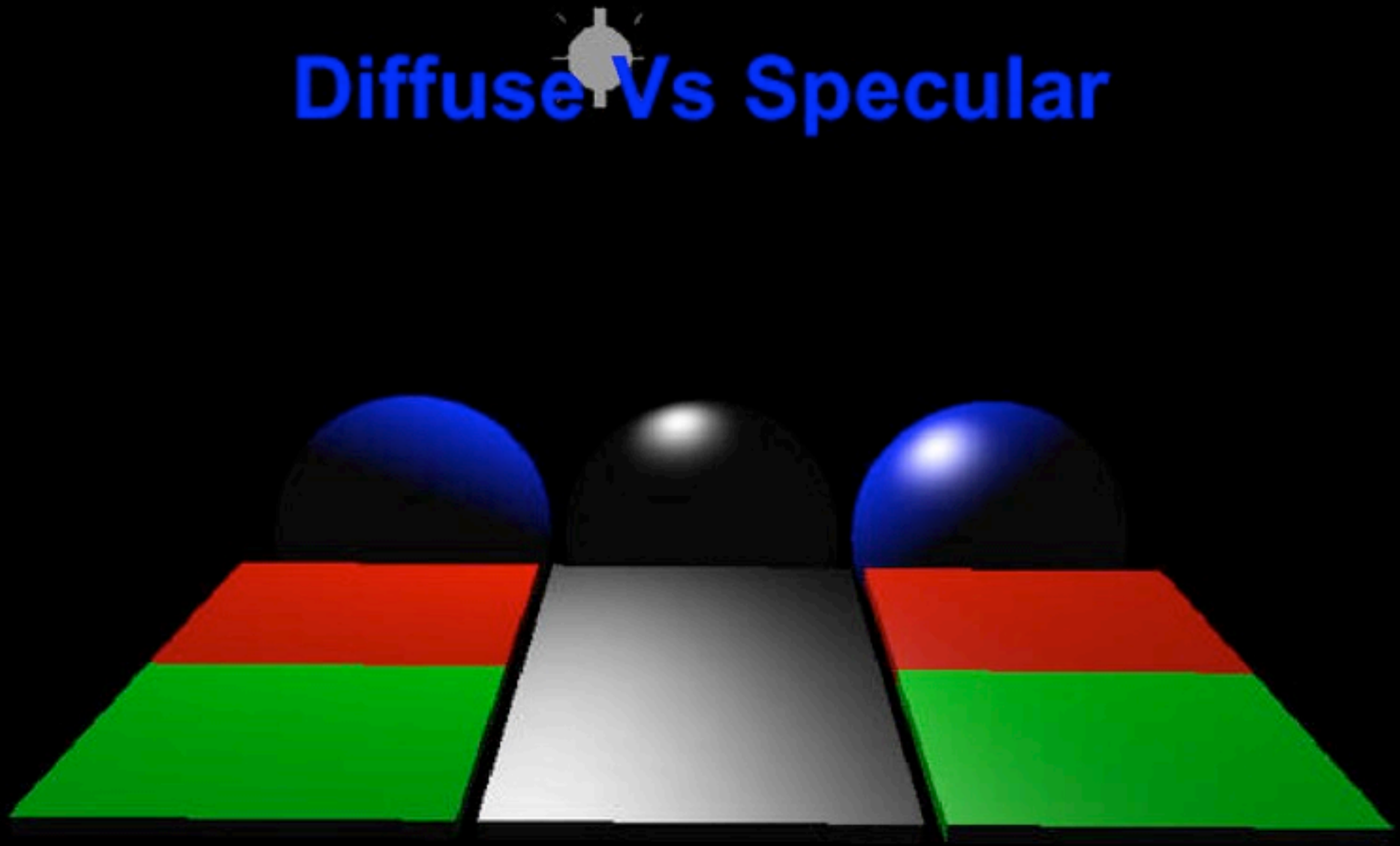
Diffuse Vs Specular



File Edit Viewing Selection Editors Manips Lights

22

Diffuse Vs Specular

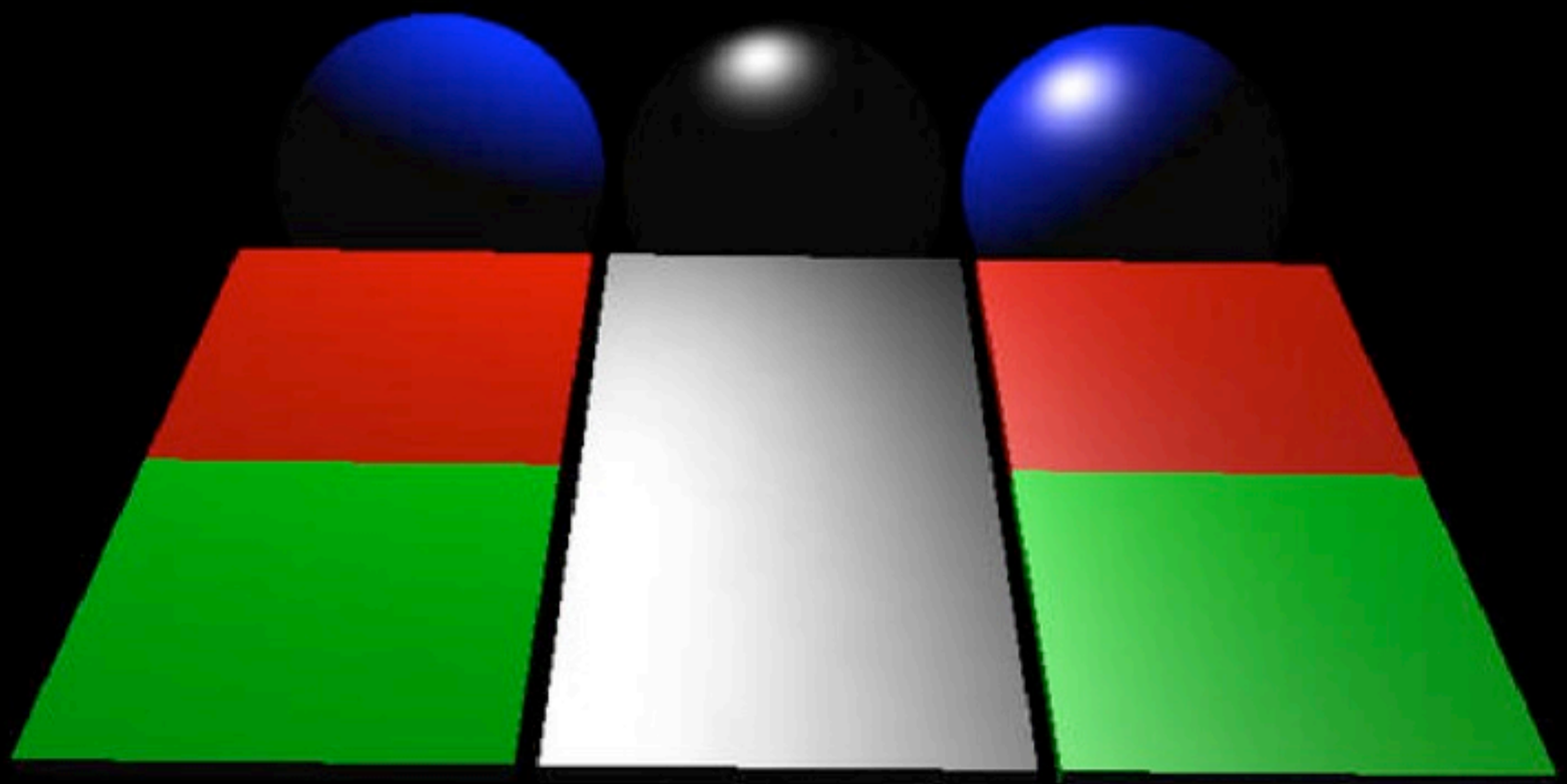


Rotx Roty Rollv

File Edit Viewing Selection Editors Manips Lights

23

Diffuse Vs Specular

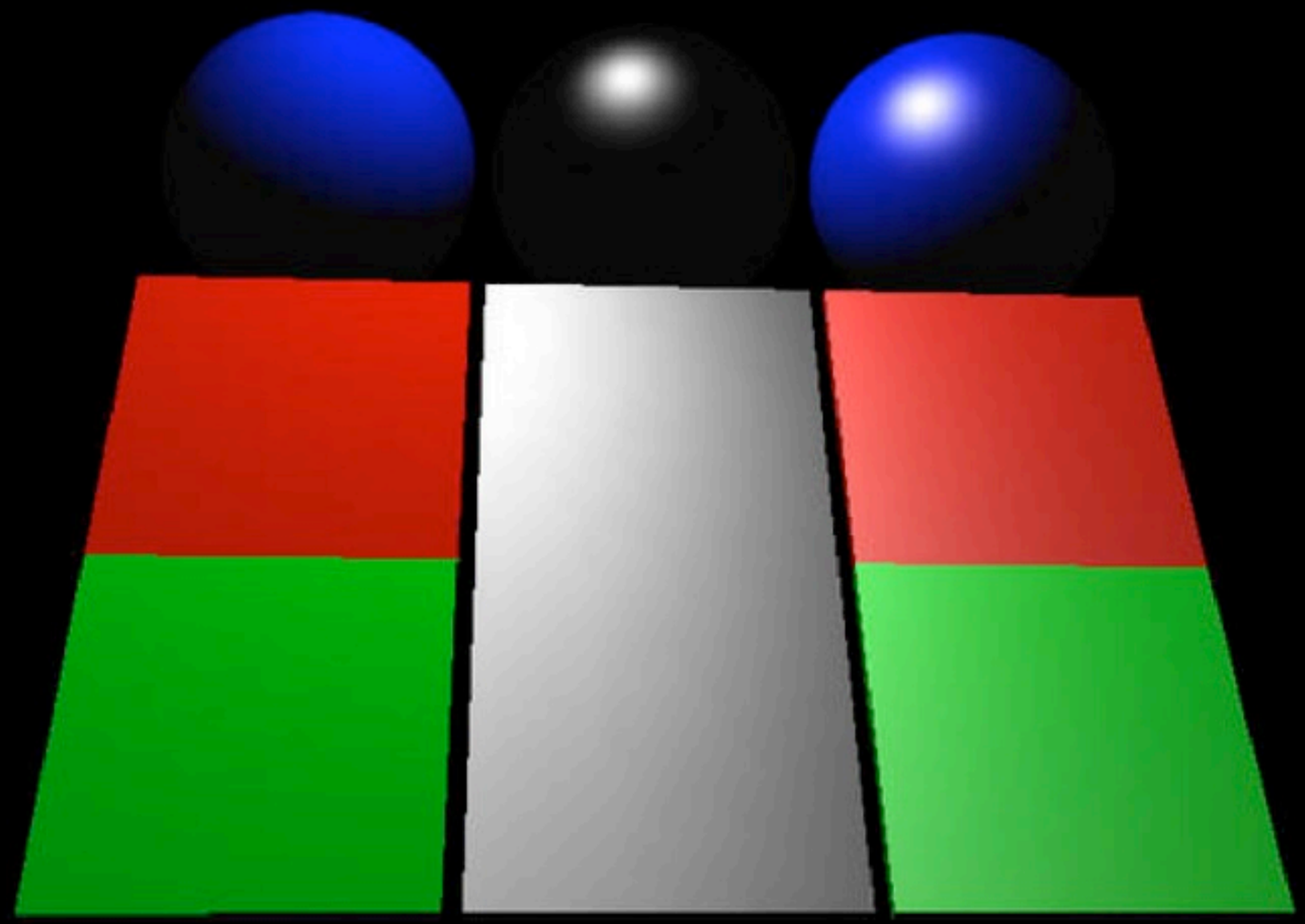


Rotx Roty Rollv

File Edit Viewing Selection Editors Manips Lights

24

Diffuse Vs Specular

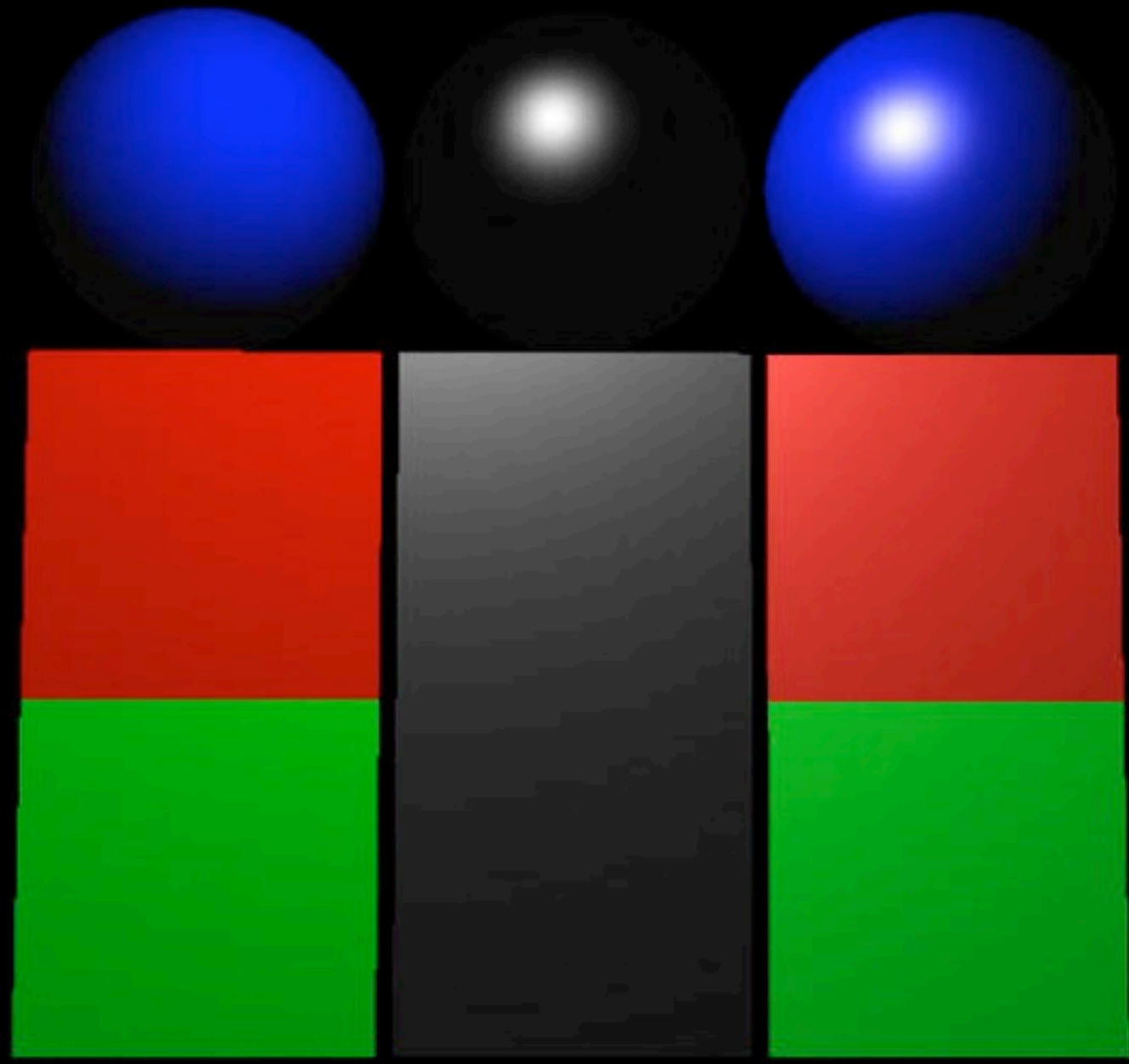


Rotx Roty Rotz Tranx Trany Tranz Scalx Scaly Scalz Pollu

File Edit Viewing Selection Editors Manips Lights

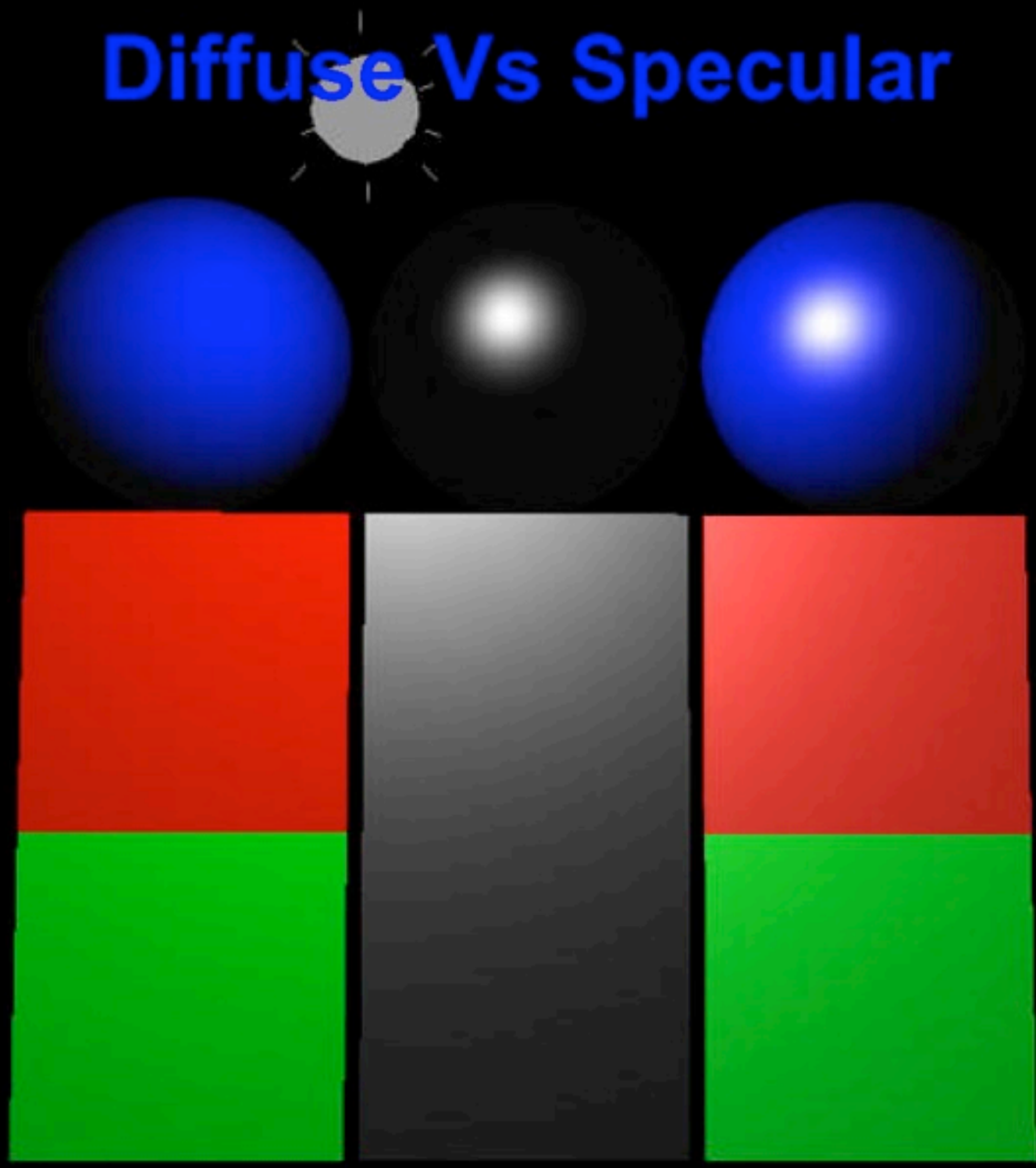
25

Diffuse Vs Specular



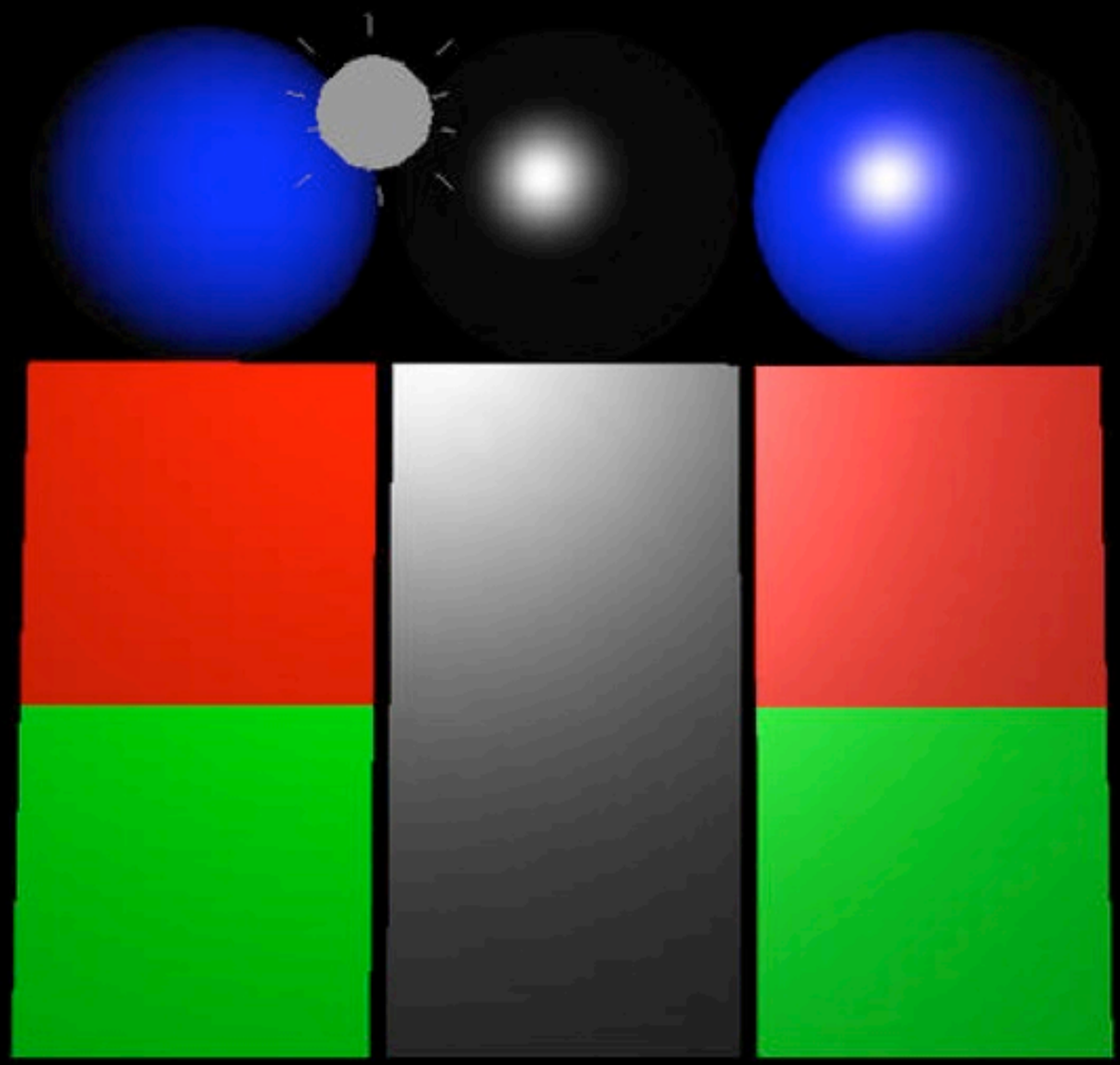
Rotx Roty Rollv

Diffuse Vs Specular



File Edit Viewing Selection Editors Manips Lights

Diffuse Vs Specular

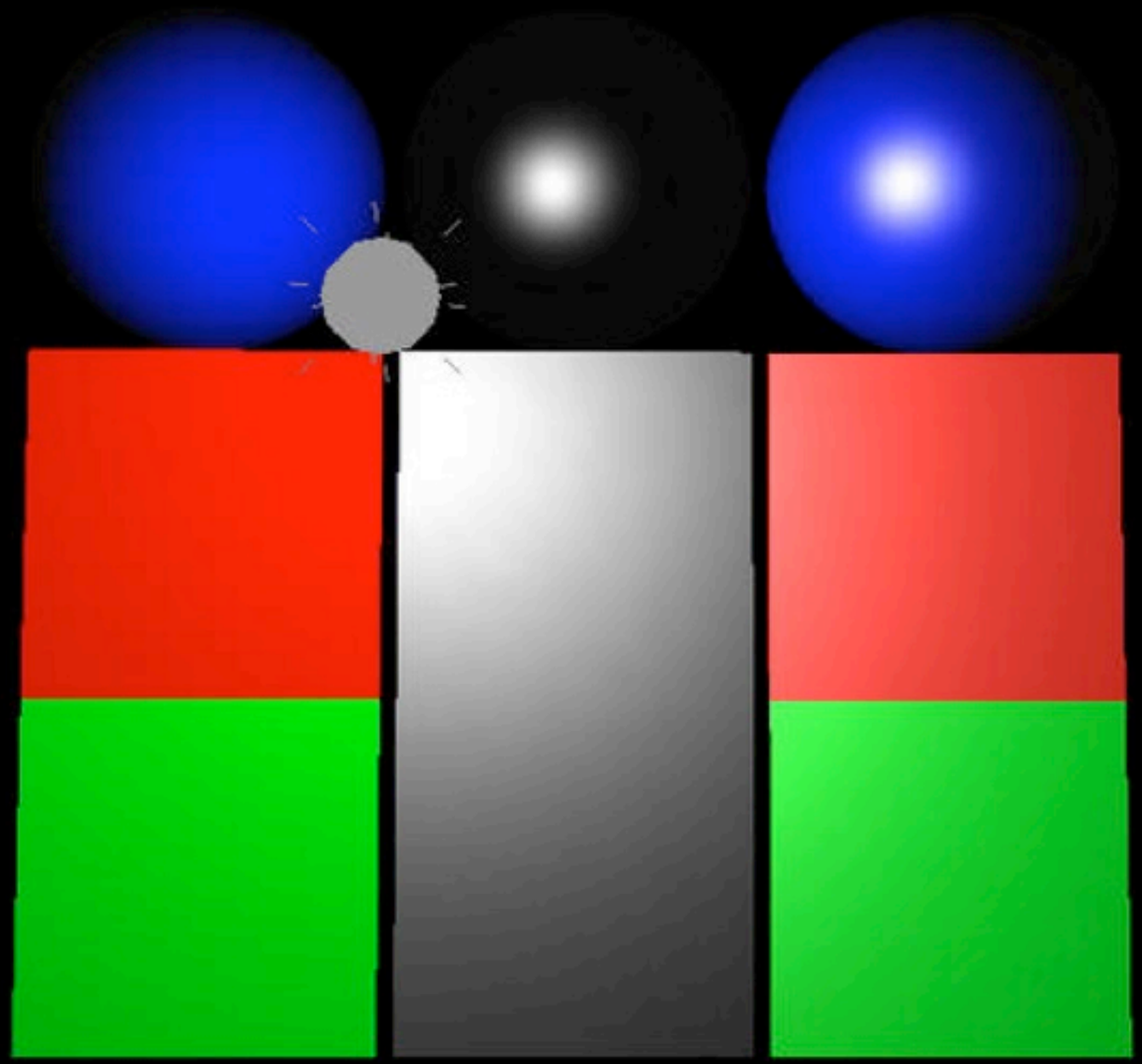


Rotx Roty Rotz Tranx Trany Tranz Scale Polly

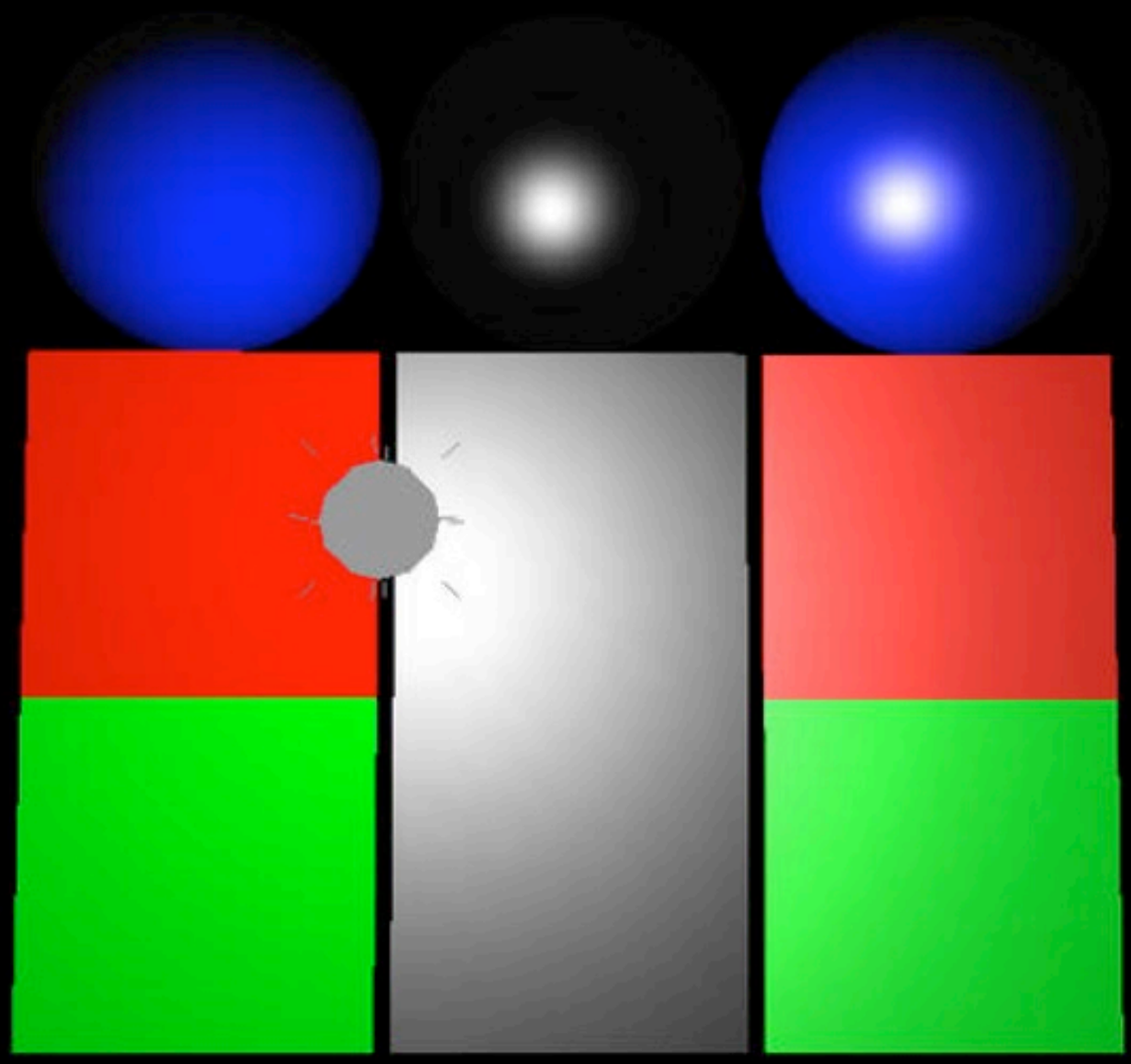
File Edit Viewing Selection Editors Manips Lights

28

Diffuse Vs Specular



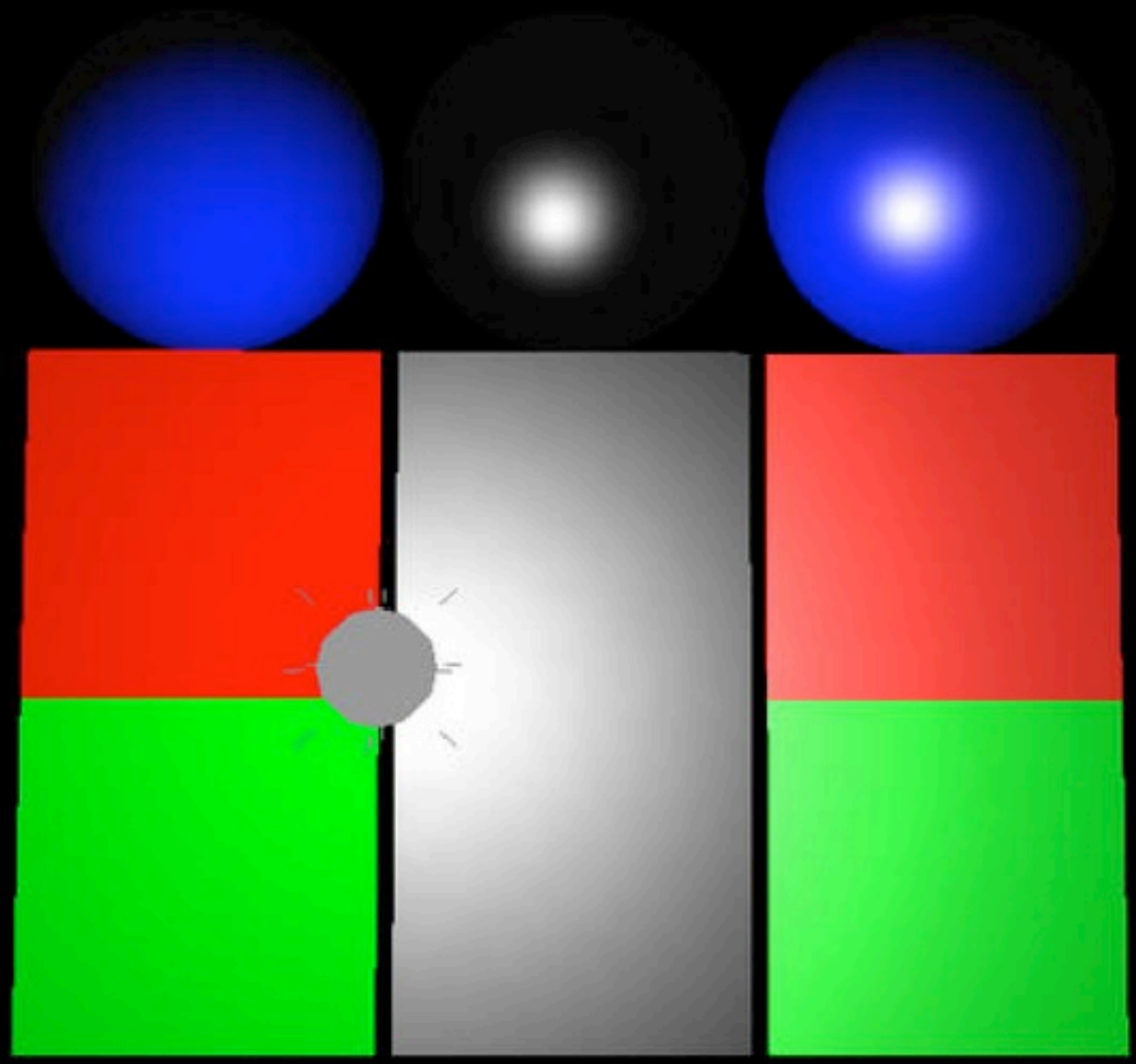
Diffuse Vs Specular



File Edit Viewing Selection Editors Manips Lights

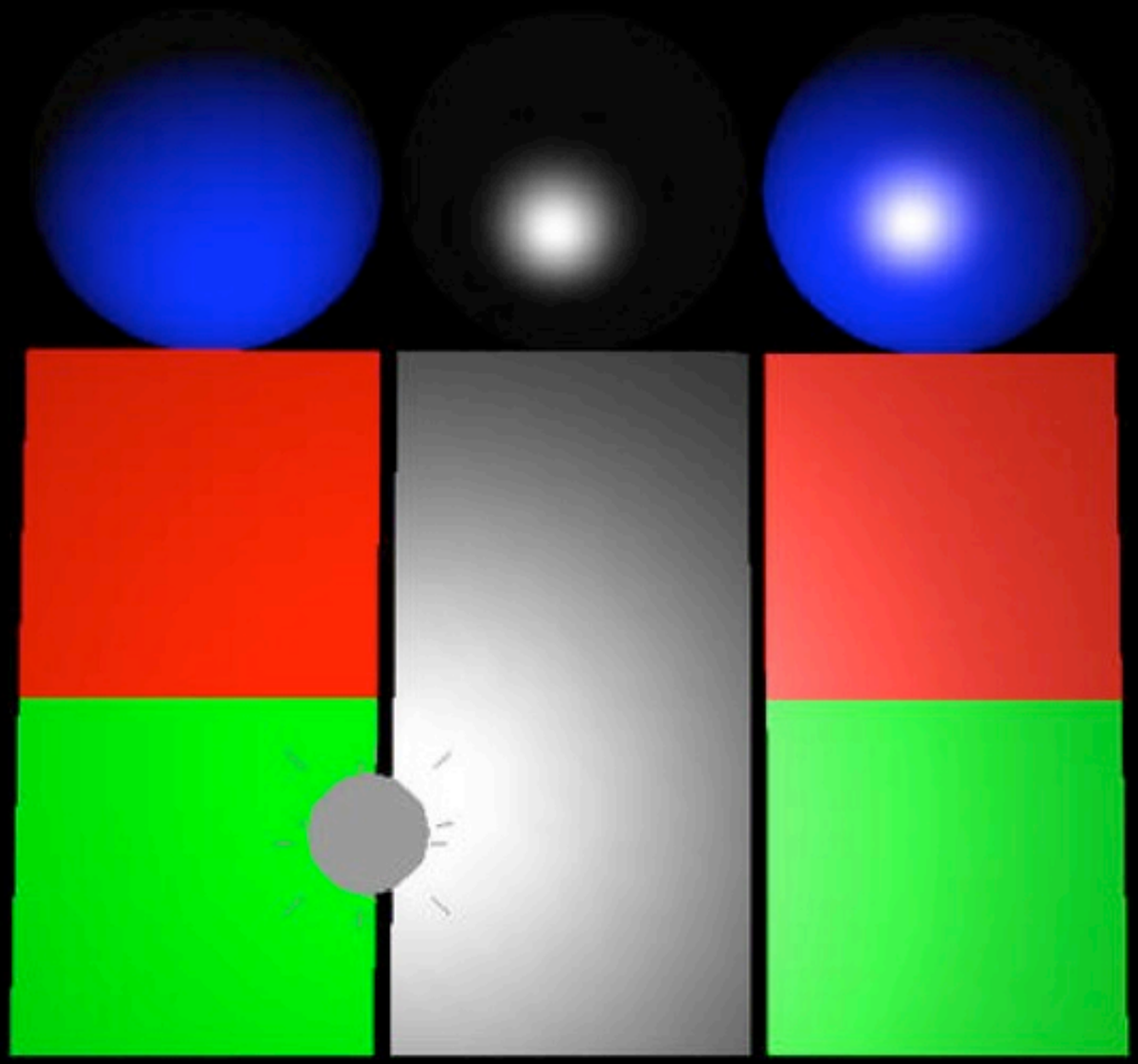
30

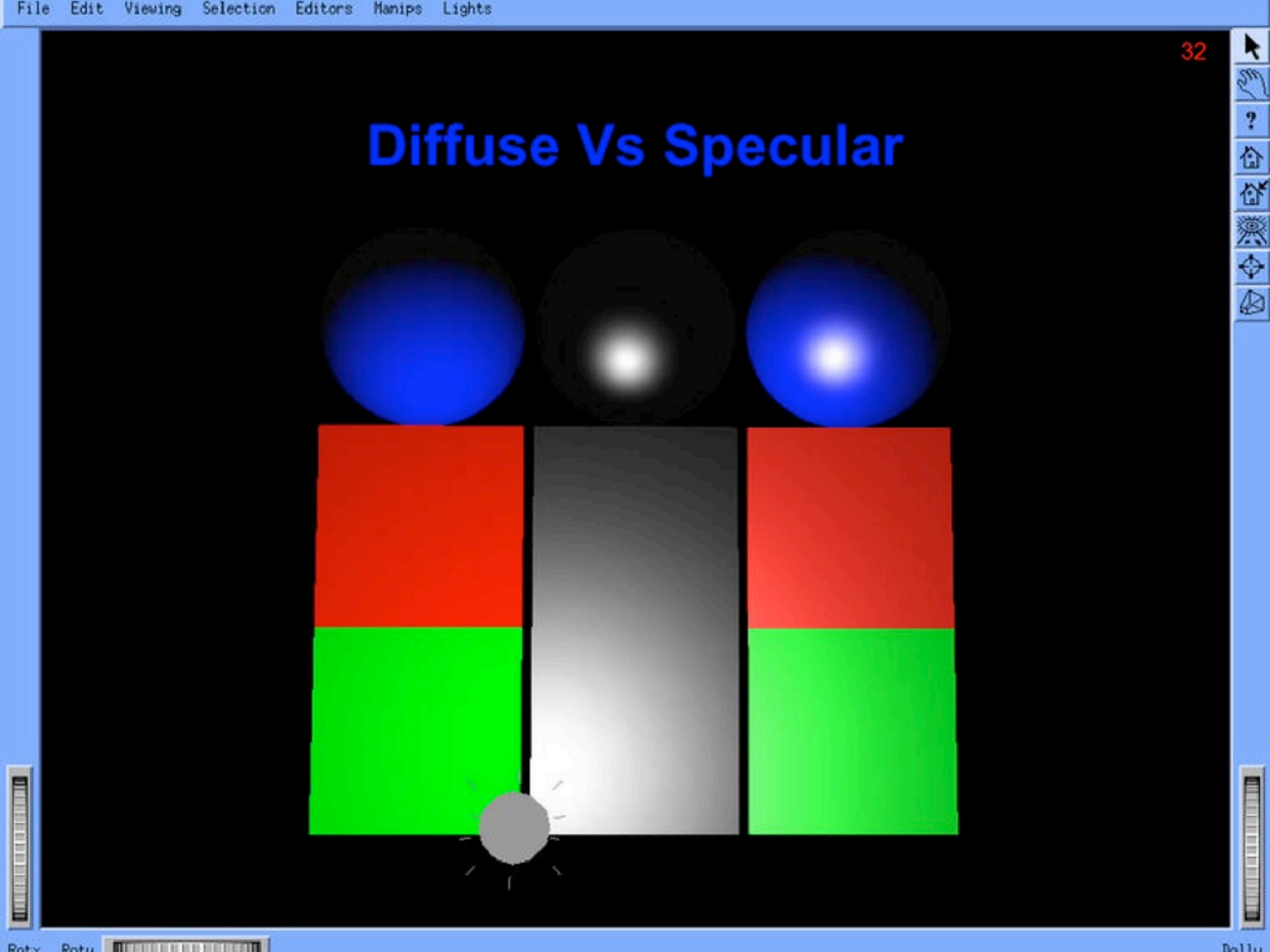
Diffuse Vs Specular



Rotx Roty Rollv

Diffuse Vs Specular

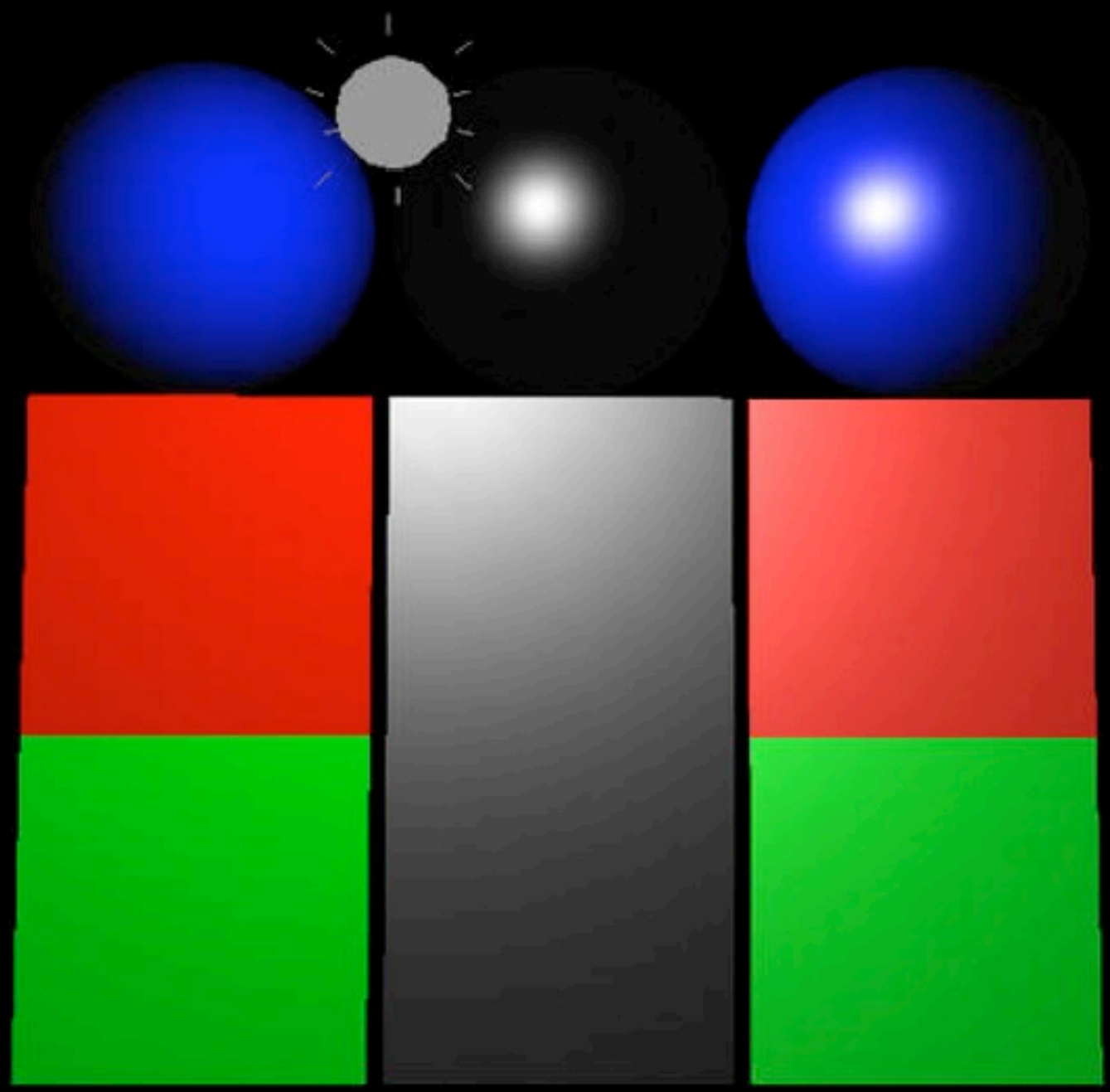



File Edit Viewing Selection Editors Manips Lights
32
Diffuse Vs Specular

File Edit Viewing Selection Editors Manips Lights

33

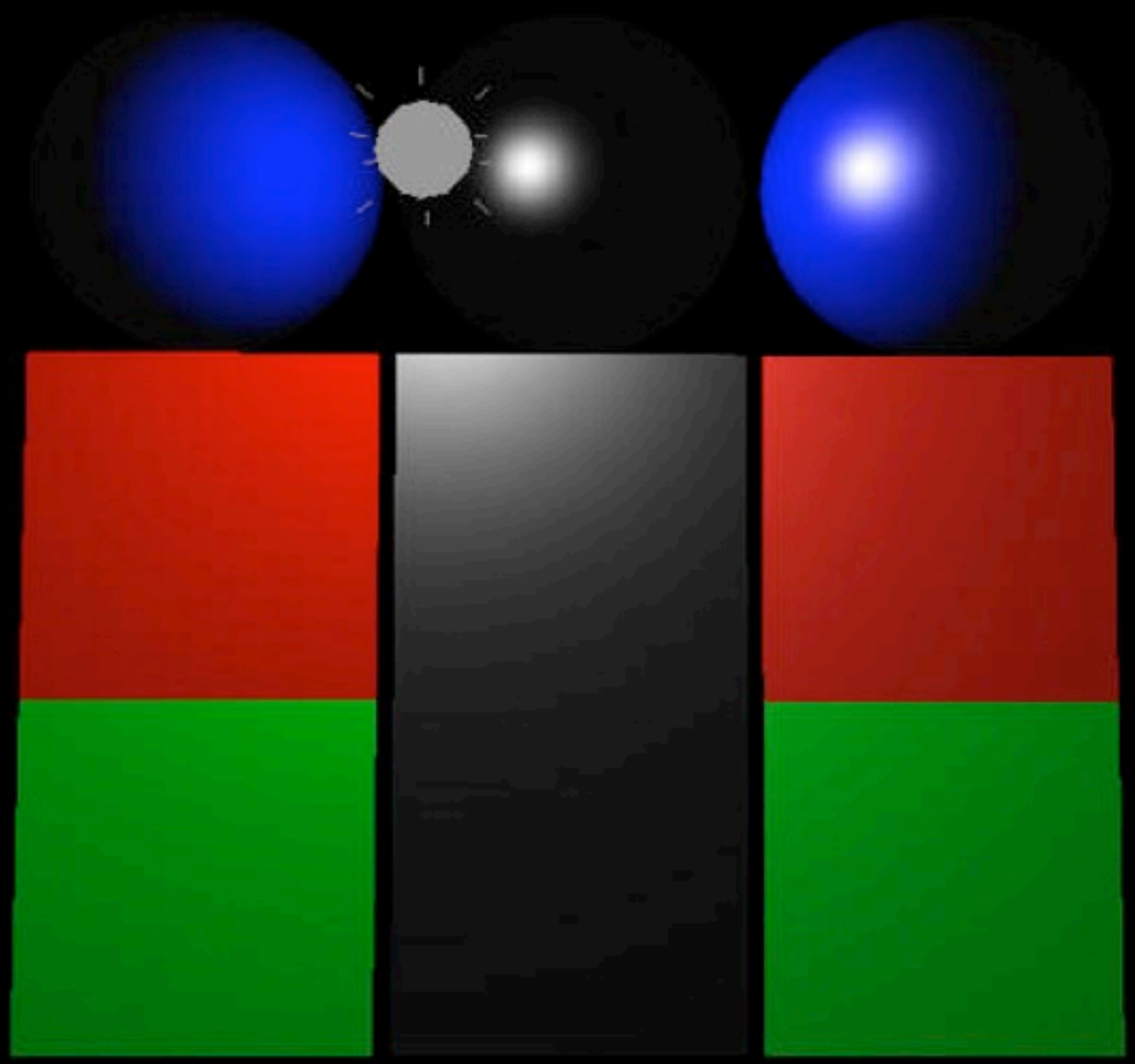
Diffuse Vs Specular



File Edit Viewing Selection Editors Manips Lights

34

Diffuse Vs Specular

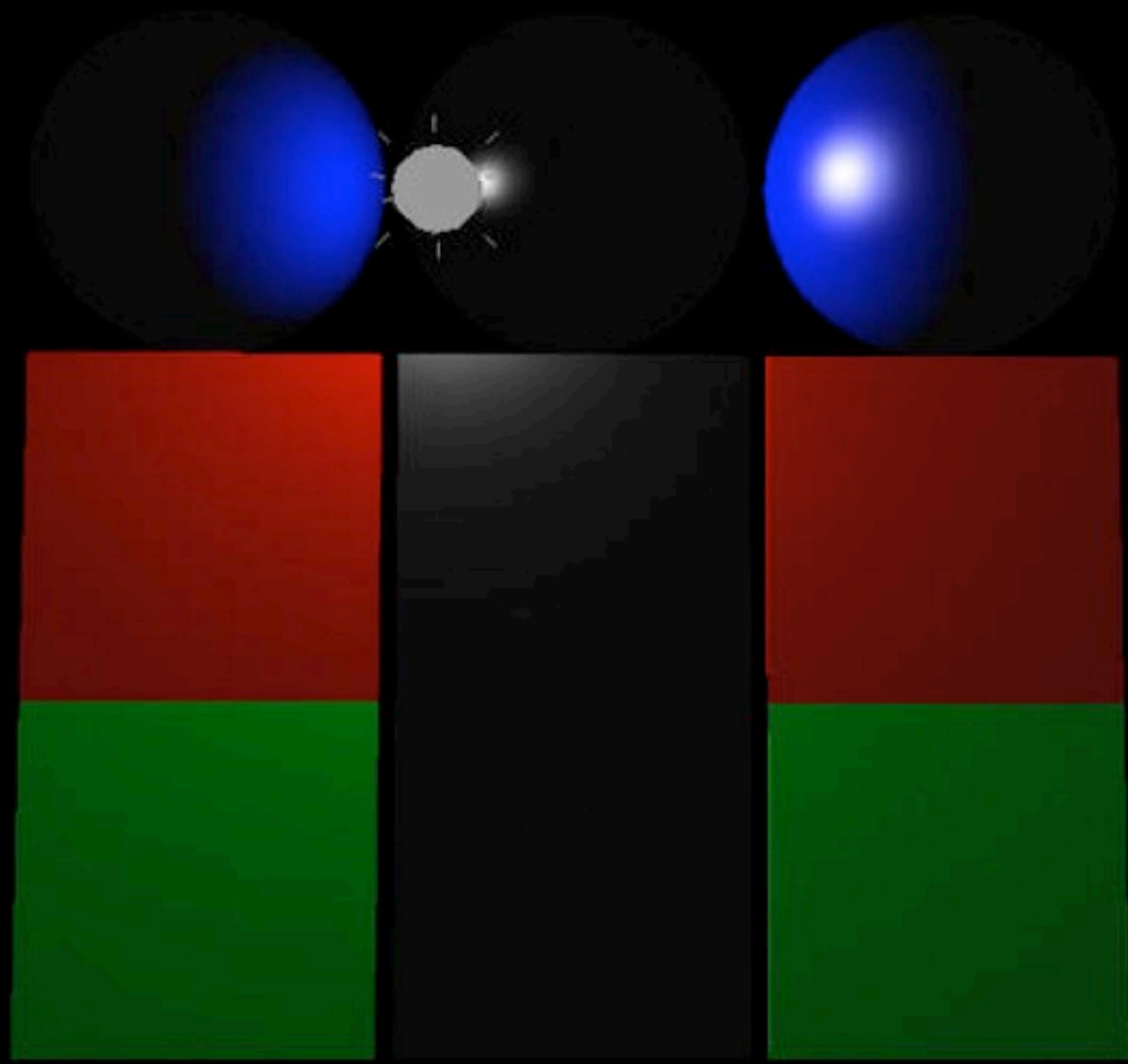


Rotx Roty Rollu

File Edit Viewing Selection Editors Manips Lights

35

Diffuse Vs Specular

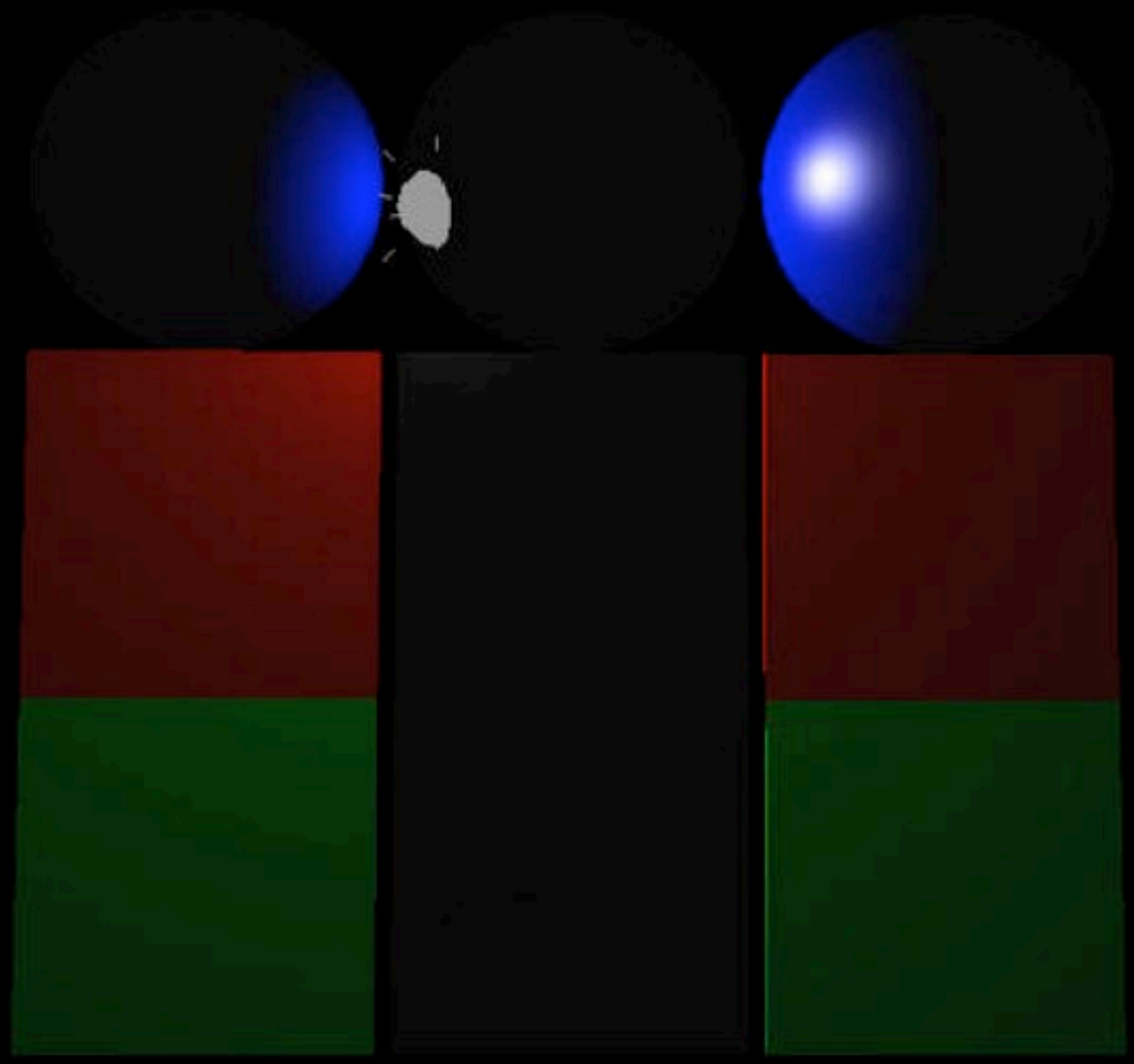


Rotx Roty Rollv

File Edit Viewing Selection Editors Manips Lights

36

Diffuse Vs Specular



Rotx Roty Rollu

Light in the shadows

Ambient light

- *To avoid complete blackness where there is no direct light, we add a small amount of constant, directionless light.*

- *This is called ambient light or ambient illumination as it approximates the light all around us.*

Simple light model

$$I_{total} = I_a k_a + I_j(k_d \mathbf{L}.\mathbf{n} + k_s(\mathbf{E}.\mathbf{R})^n)$$

where I_a is the intensity of ambient light,

I_j is the intensity of the light source

and k_a, k_d, k_s, and n are constants.

More than one light?

$$I_{total} = I_a k_a + \sum_j I_j (k_d \boldsymbol{L}.\boldsymbol{n} + k_s (\boldsymbol{E}.\boldsymbol{R})^n)$$

Shadows

A light source illuminates a surface only if there is nothing in between.

So before we add in $I_j(k_d\mathbf{L.n} + k_s(\mathbf{E.R})^n)$ *for a particular j, we need to see if the surface at that point is in shadow from light source, j.*

Shadow rays

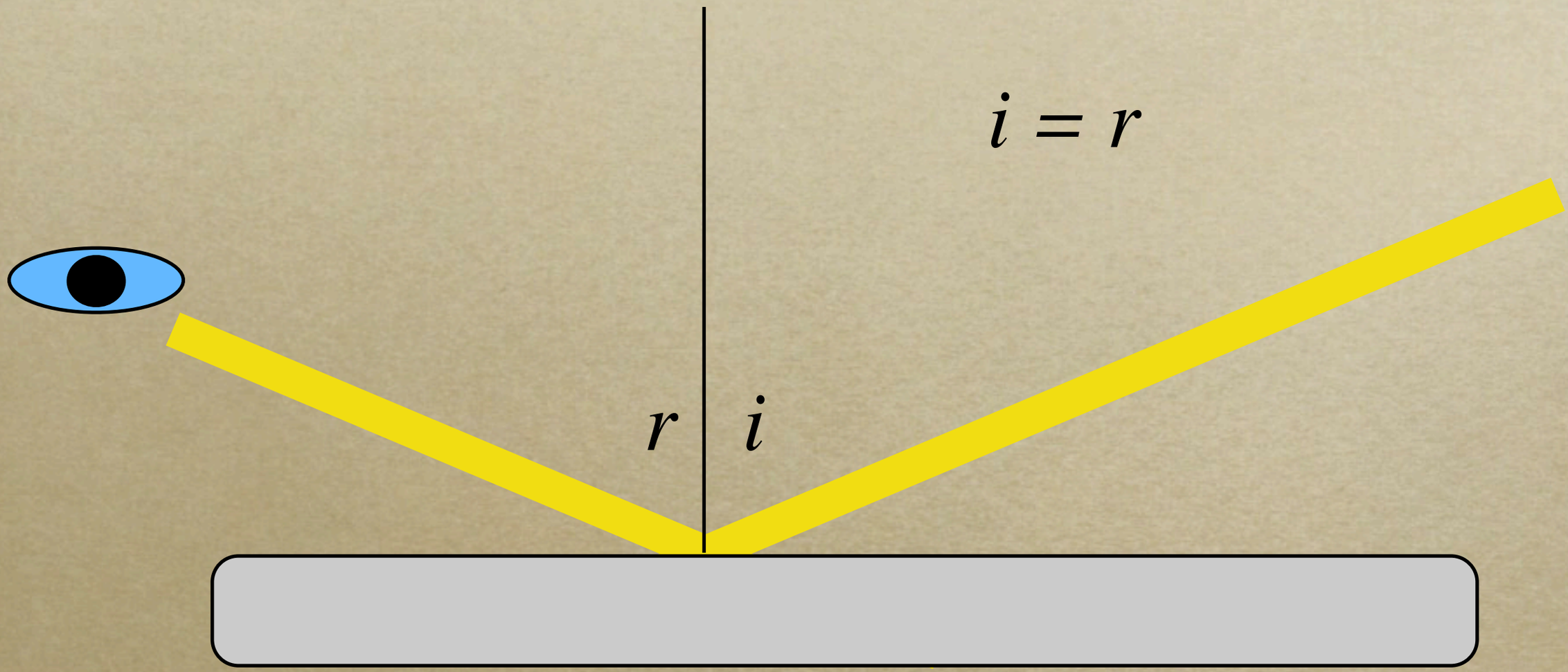
*Cast a ray from the hit point, **h**, to the light source, **j**.*

This is the ray $\mathbf{p} = \mathbf{h} + (\mathbf{j}-\mathbf{h})t$

Notice that when $t = 1$, $\mathbf{p} = \mathbf{j}$

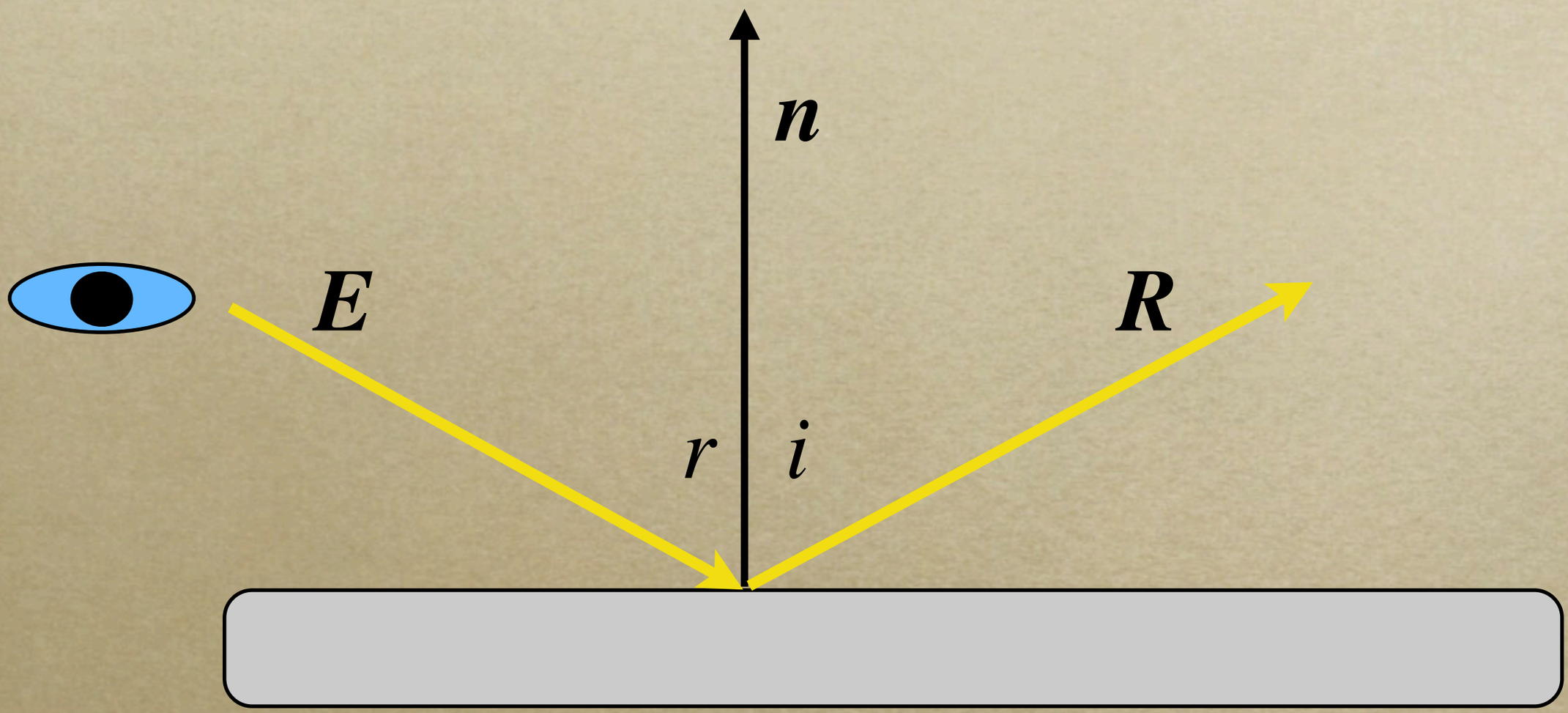
So we test this ray to see if there is an intersection with $t < 1$

Mirror reflections



There is also light from the reflected ray.

Reflections



$$\boldsymbol{R = E - 2n(E.n)}$$

Assumes ***n*** *is a unit vector.*

Truly recursive

- *So we trace a new ray in the direction* ***R***
- *Whatever we see along that line is multiplied by a reflection coefficient* k_r*, and added to the illumination of the hit point.*
- *This reflection ray can generate its own shadow and reflection rays.*

Next Lecture…

Refraction