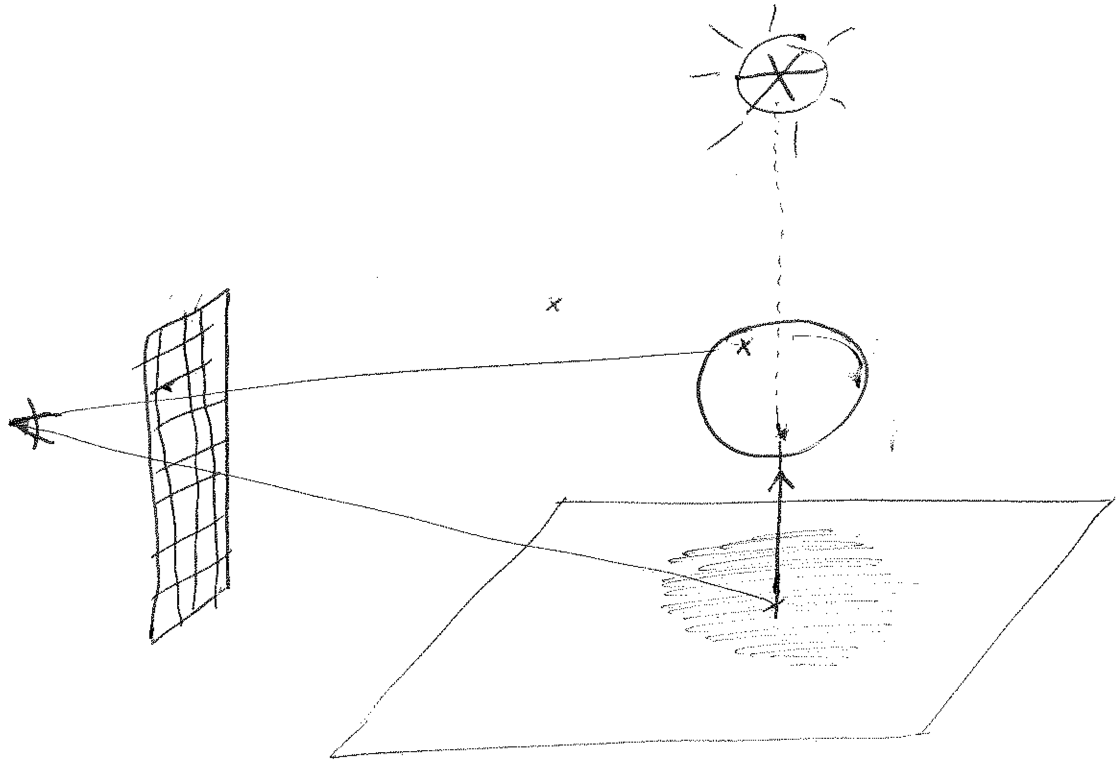


shade (x)

  c = ambient = $L_a R_a$

  for each ~~object~~ light l

    if can see l from x ← shadows

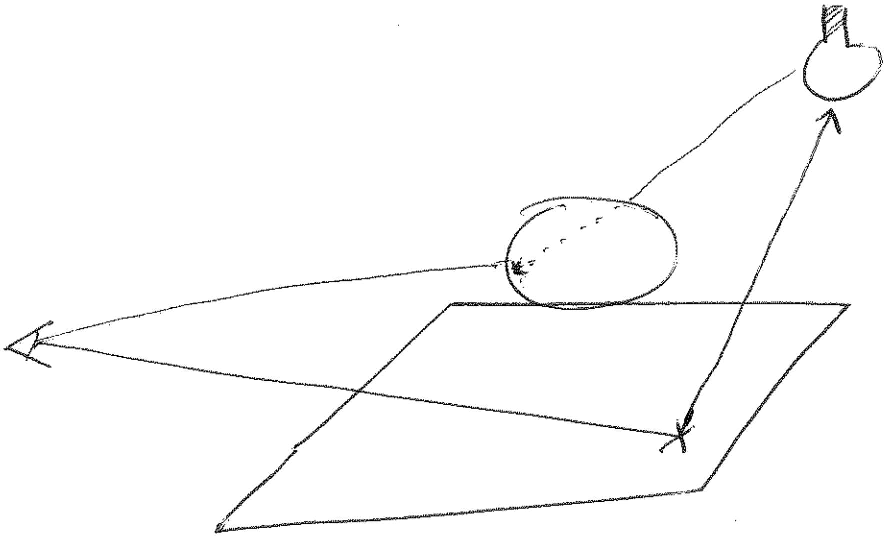
      c += $L R_d \max(0, l \cdot n) + \ldots$

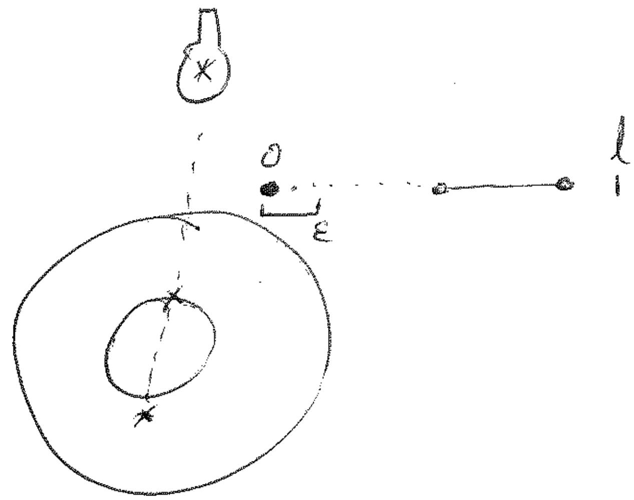
shade pixel

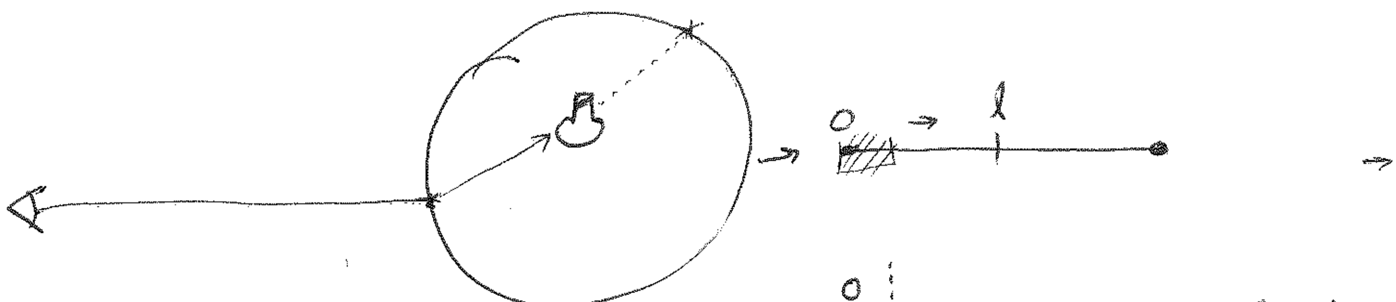
  find intersection on ray

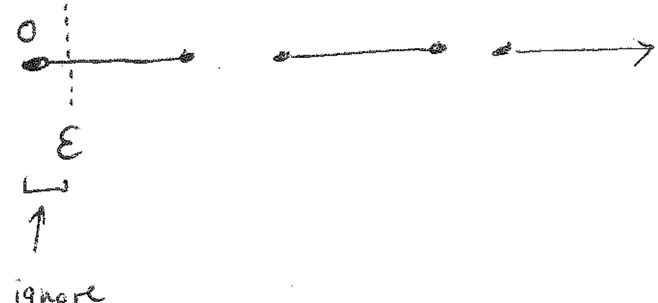
  shade ray

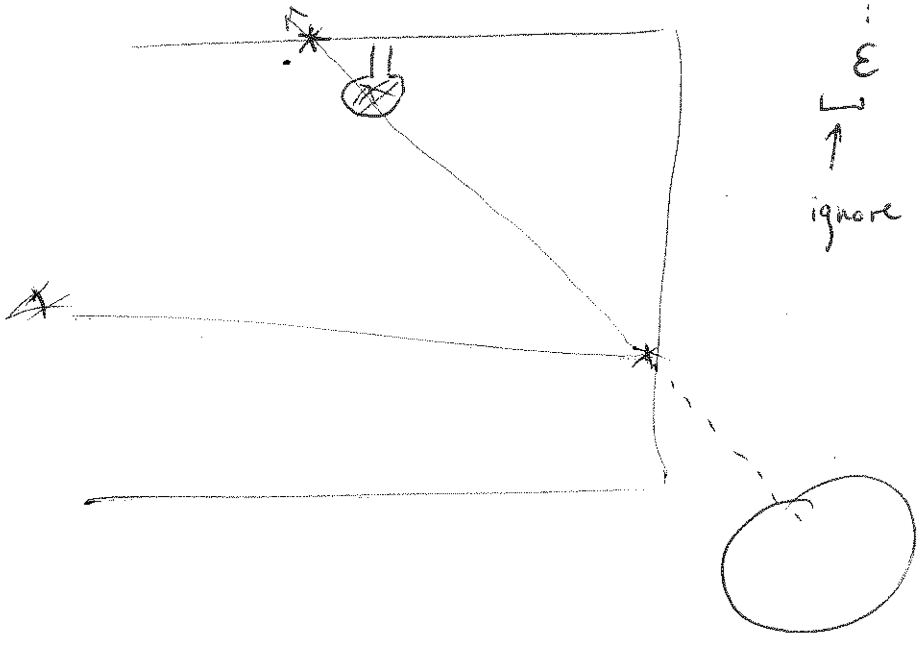
    find intersection on ray

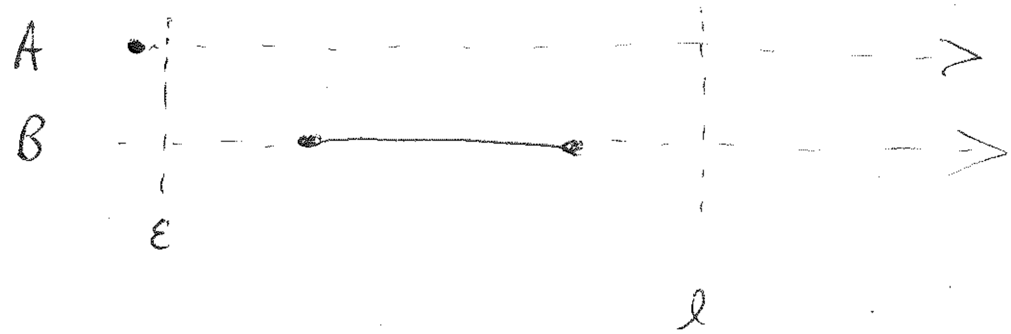


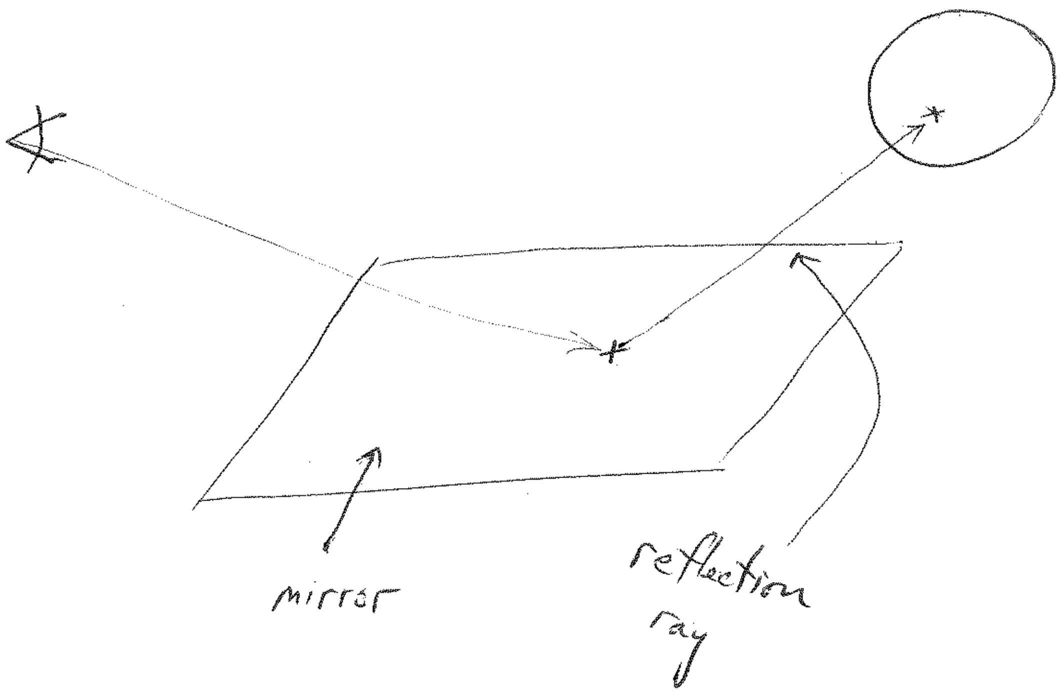

0
ε
l


0
l


0
ε
ignore




A
B
ε
ℓ



shading reflective object

→ shade surface $= C_o$

→ shade reflection ray $= C_r$

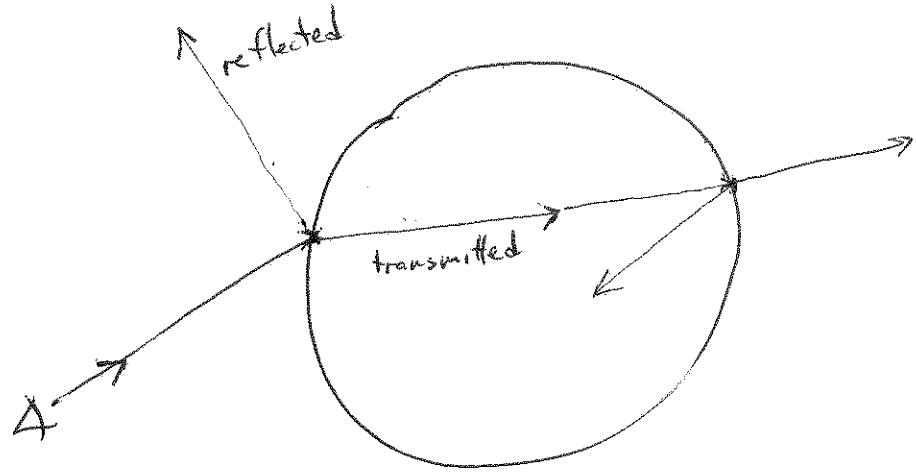
reflectance $= \beta \in [0,1]$

color $= C_o + \beta(C_r - C_o)$

$\beta = 0 \Rightarrow C_o$

$\beta = 1 \Rightarrow C_r$

Transparent Shader



color of object = C_o
reflection = C_r
transmitted = C_t

$$\text{color} = C_o + \beta(C_r - C_o) + \gamma(C_t - C_o)$$

↑ reflectance ↑ transmissive

$\beta + \gamma = 1$

$\beta \geq 0$

$\gamma \geq 0$

---

transmitted ray direction

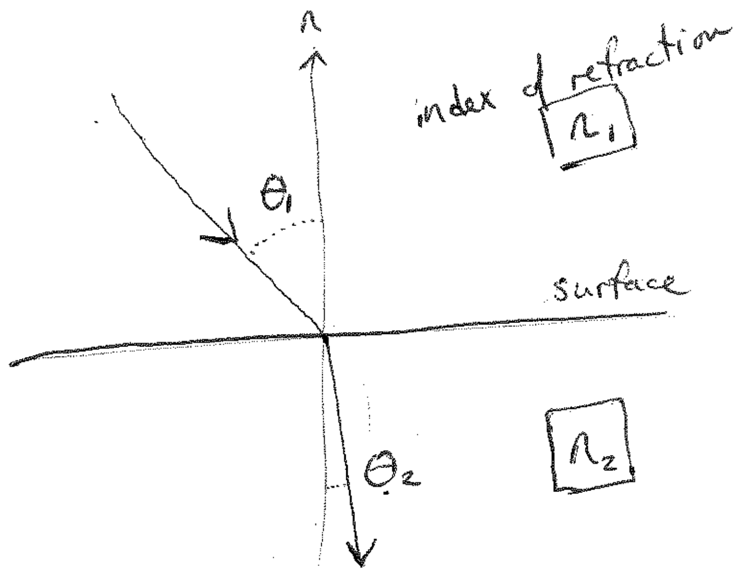
vacuum : $n = 1$

air : $n \approx 1$

water : $n \approx 1.33$

glass : $n \approx 1.46$

diamond : $n \approx 2.42$



Snell's law

$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{n_1}{n_2}$$

$$\sin\theta_2 = \frac{n_2}{n_1}\sin\theta_1 \leq 1$$

what if > 1?

complete internal reflection

all reflected, no transmitted

Are β and γ independent?

fresnel equations relate β and γ.

$\beta + \gamma$ is chosen