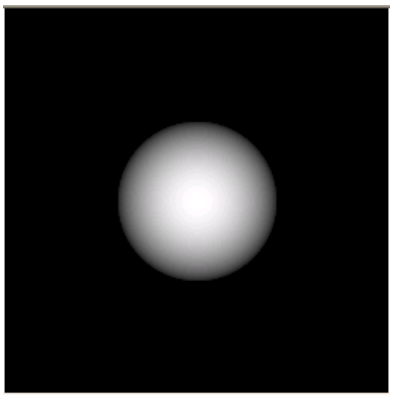
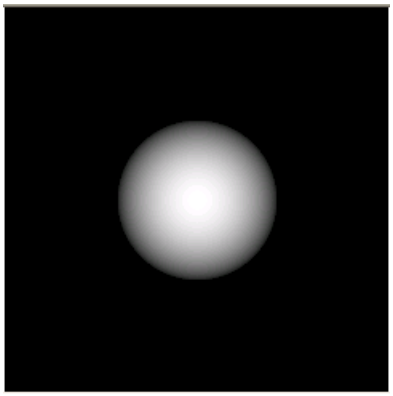
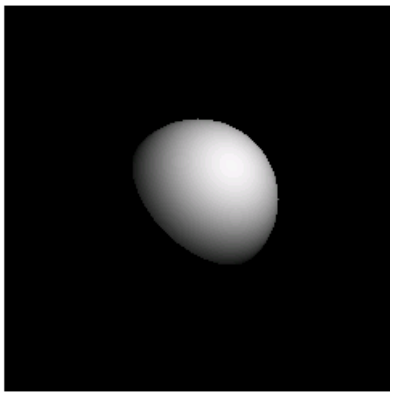
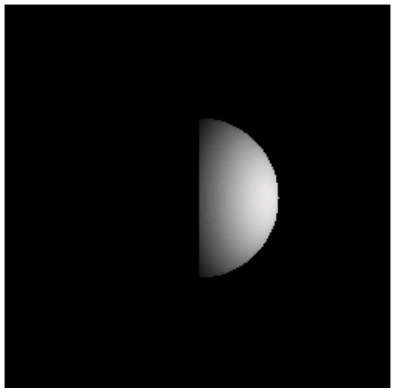
The unnormalized surface normal has the following form

$$N = \begin{cases} \left[\frac{x}{\sqrt{r^2-(x^2+y^2)}}, \frac{y}{\sqrt{r^2-(x^2+y^2)}}, 1\right], r^2 > (x^2+y^2) \\ [x, y, 0], r^2 = (x^2+y^2) \end{cases}$$

a) S = [0, 0, 1], r = 50, a = 0.5, m = 1



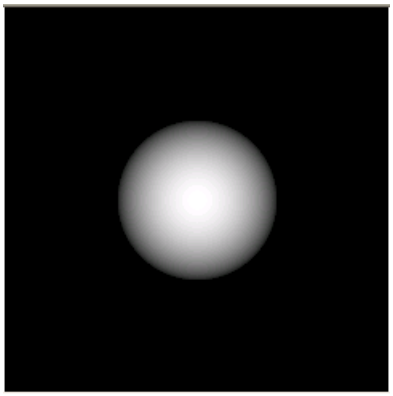
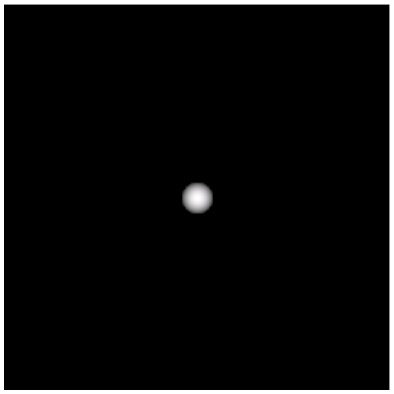
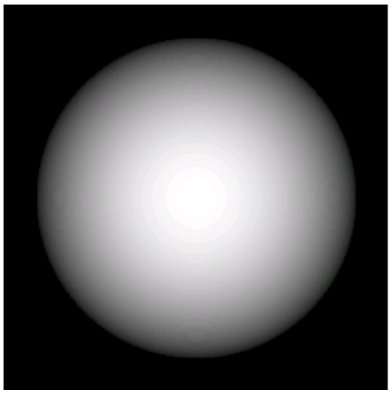
b) Vary S

S = [0, 0, 1] S = $[1/\sqrt{3}, 1/\sqrt{3}, 1/\sqrt{3}]$ S = [1, 0, 0]

As S changes, different parts are illuminated.

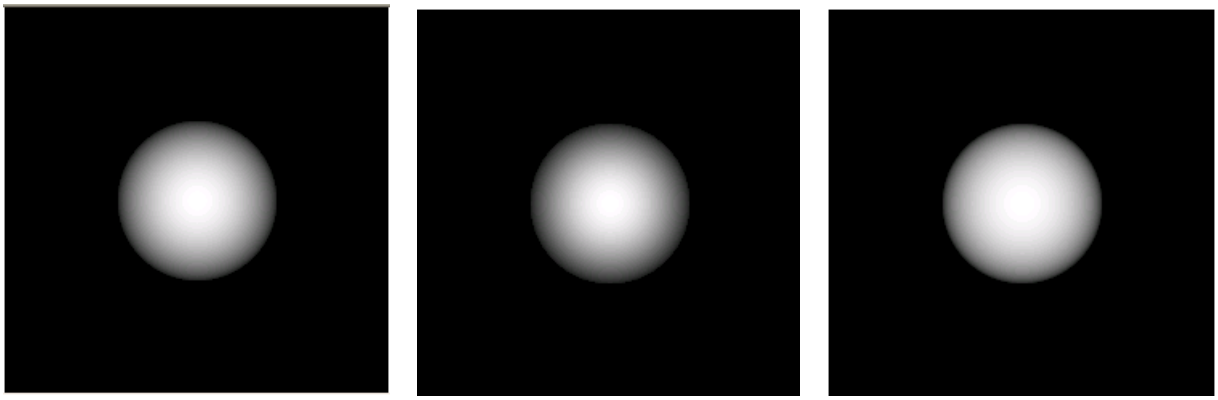
c) Vary r

r = 50 r = 10 r = 100

As r increases, more pixels receive irradiance.

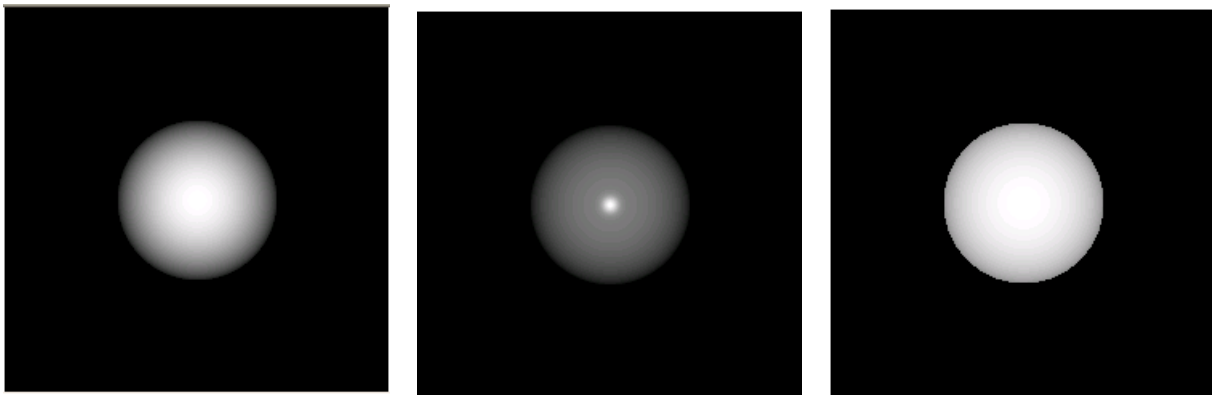
d) Vary a



a = 0.5 a = 0.1 a = 1

The larger a, the more dominant lambertian reflection is. With a = 1, a sphere looks like a disk.

e) Vary m



m = 1 m = 0.1 m = 10000

With large m, the exponential falls off slowly, making specular effect less evident. With small m, the exponential falls off quickly, making specular effect more evident.