The unnormalized surface normal $(-p, -q, 1)$

$$p = \frac{\partial z}{\partial x} \quad q = \frac{\partial z}{\partial y}$$

$$\hat{N} \text{ (unit surface normal)} = \frac{(-p, -q, 1)}{\sqrt{p^2+q^2+1}}$$

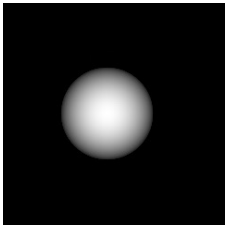
$$z = z_0 + \sqrt{r^2 - (x^2+y^2)} \qquad x^2 + y^2 \le r^2$$

$$p = \frac{-x}{\sqrt{r^2-(x^2+y^2)}} \qquad q = \frac{-y}{\sqrt{r^2-(x^2+y^2)}}$$

The unnormalized surface normal ↓

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

Vary S

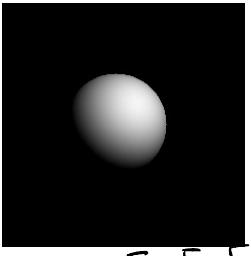


(a)
$S = [0, 0, 1]$

$r = 50$

$a = 0.5$

$m = 1$

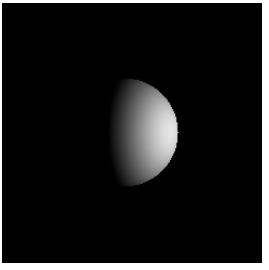


(b)
$S = [\frac{\sqrt{3}}{3}, \frac{\sqrt{3}}{3}, \frac{\sqrt{3}}{3}]$

$r = 50$

$a = 0.5$

$m = 1$



(c)
$S = [1, 0, 0]$

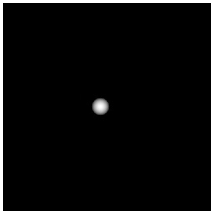
$r = 50$

$a = 0.5$

$m = 1$

Through changing S, the illumination towards the sphere will change and different parts are illuminated.

Vary r.



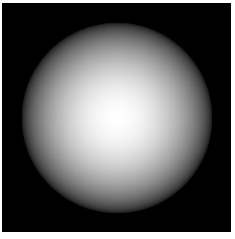
(d)

$S=[0,0,1]$

$r=10$

$a=0.5$

$m=1$



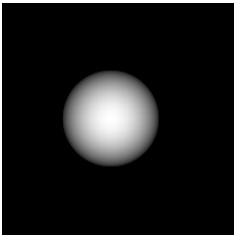
(e)

$S=[0,0,1]$

$r=100$

$a=0.5$

$m=1$



(a)

$S=[0,0,1]$

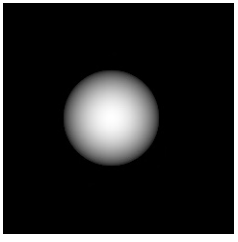
$r=50$

$a=0.5$

$m=1$

Through r getting bigger, more pixels receive irradiance.

Vary a.



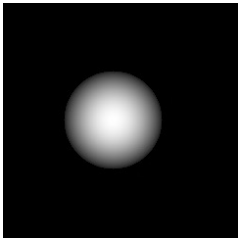
a)

$S=[0,0,1]$

$r=50$

$a=0.5$

$m=1$



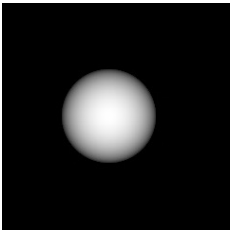
f)

$S=[0,0,1]$

$r=50$

$a=0.1$

$m=1$



g)

$S=[0,0,1]$

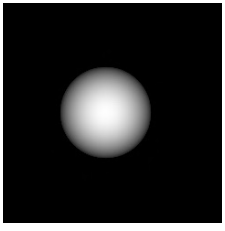
$r=50$

$a=1$

$m=1$

The larger a, the more dominant lambertian reflection is.

Vary m.



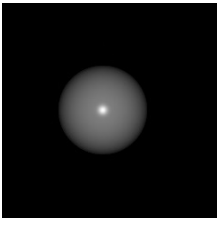
a)

S=[0,0|]

r=50

a=0.5

m=1



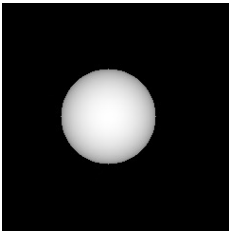
h)

S=[0,0|]

r=50

a=0.5

m=0.1



i)

S=[0,0,1]

r=50

a=0.5

m=10000.

Through the m increasing, specular effect turns less evident.