# Ray 1

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## 1.1a

The surface of the Earth is $x^2 + y^2 + z^2 - 1 = 0$. Given the position of spacecraft and the direction of the ray, the ray of camera is $4x - 3z = 0, x < 15$. To find the intersection point, we will combine these two equation and find two solutions. The first is $x = 3/5, y = 0, z = 4/5$, while the second is $x = -3/5, y = 0, z = -4/5$. The latter solution is on the shadow of the earth. Thus, the first solution is P=(0.6, 0, 0.8).

## 1.1b

The ray from sun to moon is $y - 0.91 = 0$. The distance from ray to earth center is 0.91, which is smaller than the radius of the earth. Thus, point(0,0.91,-9.88) is in the shadow of earth.

## 1.2

According to the equation $L_d = \frac{R}{\pi}\frac{max(0, n \cdot l)}{r^2} I$,
where $k = \frac{R}{\pi} = 0.5, max(0, n \cdot l) = 4/5, I = 100,000,000, r = 23679$,
we can finally calculate the final result is 0.07134

## 2

First of all, we need to calculate the norm vector of each face.
$F_{ACB} = (C - A) \times (B - A) = (0, -2\sqrt{2}, -2)$
$F_{ABD} = (B - A) \times (D - A) = (2\sqrt{2}, 0, 2)$
$F_{ADC} = (D - A) \times (C - A) = (-2\sqrt{2}, 0, 2)$
$F_{DBC} = (B - D) \times (C - D) = (0, 2\sqrt{2}, -2)$
The normalization could be calculated in the last step.

Now, we can get the norm for vector A,B,D
$N_A = \frac{1}{3} * (F_{ACB} + F_{ABD} + F_{ADC}) = (0, -\frac{2\sqrt{2}}{3}, \frac{2}{3})$
$N_B = \frac{1}{3} * (F_{ACB} + F_{ABD} + F_{DBC}) = (\frac{2\sqrt{2}}{3}, 0, -\frac{2}{3})$
$N_D = \frac{1}{3} * (F_{DBC} + F_{ABD} + F_{ADC}) = (0, \frac{2\sqrt{2}}{3}, \frac{2}{3})$

According to 1:1:4 distance to edges, the point E can be writen as
P=$A + \frac{1}{6}(B - A) + \frac{1}{6}(D - A)$
Then we can calculate the norm for P:
$Norm_P = norm(\frac{2}{3}N_A + \frac{1}{6}N_B + \frac{1}{6}N_D) = (\frac{\sqrt{2}}{6}, -\frac{\sqrt{2}}{2}, \frac{2}{3})$