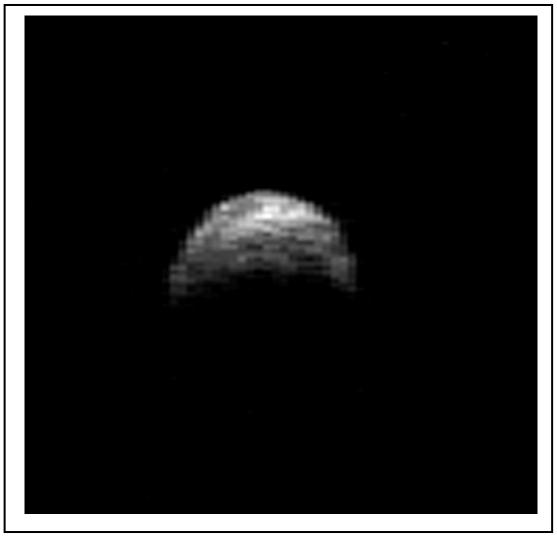
The Closest Approach of Asteroid 2005 YU55 - III



NASA scientists will be tracking asteroid 2005 YU55 with antennas of the agency's Deep Space Network at Goldstone, Calif., as the space rock safely flies past Earth slightly closer than the moon's orbit on Nov. 8.

Scientists are treating the flyby of the 1,300-foot-wide (400-meter) asteroid as a science target of opportunity – allowing instruments on "spacecraft Earth" to scan it during the close pass.

The image above was made at radio wavelengths by the Arecibo Radio Telescope in Puerto Rico in April, 2011. (Credit NASA/Cornell/Arecibo). The trajectory of asteroid 2005 YU55 is well understood.

On a standard Cartesian grid with Earth at the Origin, the Asteroid is predicted to be located at Point A (-247, -543) on November 8.438, and at Point B (+506, +1360 on November 9.438. The Moons orbit is represented by a circle with a radius of 346. All units are in thousands of kilometers so '346' is 346,000 kilometers.

Problem 1 - What is the slope-intercept form of the linear equation that represents the trajectory of the Asteroid between November 8 and November 9?

Problem 2 - What is the equation representing the orbit of the moon?

Problem 3 - What are the coordinates of the points that represent the intersection of the asteroid's trajectory and the lunar orbit?

Problem 4 - Over how many hours will the asteroid be inside the orbit of the moon if the asteroid was traveling at a speed of 41,700 km/hr?

Problem 5 - If the closest distance to Earth occurs when the asteroid is at the mid-point of its time inside the orbit of the Moon, A) about when does this happen and B) what is the distance to Earth at that time?

Problem 1 - Answer: Start with the two-point formula and simplify to the slop-intercept form.

$y - y_1 = \frac{(y_2 - y_1)}{(x_2 - x_1)}(x - x_1)$ so $y + 543 = \frac{(136 + 543)}{(506 + 247)}(x + 247)$ and so **y = 0.902x - 320**

Problem 2 - Answer: r = 346 so $x^2 + y^2 = (346)^2$

Problem 3 - Answer: Eliminate y in the equation for the lunar orbit by substituting the linear equation formula. Then solve the quadratic equation for the intersection points.

$x^2 + (0.902x - 320)^2 = (346)^2$ so $1.814x^2 - 577x - 17316 = 0$

use the quadratic formula with a = 1.814, b=-577 and c = -17316 to get:

$x = \frac{577 \pm \sqrt{(577^2 - 4(1.814)(-17316))}}{2(1.814)}$ so x = 159 +/- 187 x1 = +346 and x2 = -28

Find the corresponding y coordinates
Y1 = 0.902(346) - 320 = -8.0 so **First Point = (+346,-8.0)**
Y2 = 0.902(-28) - 320 = -345. so **Second Point = (-28, -345)**

Note, if you use the equation for the circle, you get y1 = 0.0 and y2 = -345. so **First Point (+346,0.0)** and **Second Point (-28, -345)**. The differences can be attributed to rounding error.

Problem 4 - Answer: Using the linear equation result, the distance between the First and Second Points is

$d = \sqrt{(-28 - 346)^2 + (-345 + 8)^2}$ so d = 503 units or 503,000 km. At a speed of 41,700 km/h, the asteroid travels this distance in about **12.1 hours**.

Problem 5 - If the closest distance to Earth occurs when the asteroid is at the mid-point of its time inside the orbit of the Moon, A) about when does this happen and B) what is the distance to Earth at that time?
Answer: T(mid) = (12.1)/2 = 6.05 hours.
Distance from Point A (-247, -543) to the Second Point at (-28, -345) is

$d = \sqrt{(-28 + 247)^2 + (-345 + 543)^2}$ so d = 295 or 295,000 km. At a speed of 41,700 km/h this time interval is just 7.07 hours. Adding the two times together we get 5.25+7.07 = 12.32 hours or 0.51 days after Point A. Since Point A occurs on November 8.438d we add 0.51d to this and get
A) **November 8.95 or November 8 at 22:48 Universal Time**.

B) The point that is half way between the
First point (+346,-8.0) and the Second point (-28, -345) is at
x=(346-28)/2= +159, and y = (-345 - 8)/2 = -177.
This point is located at a distance of $d = \sqrt{(159)^2 + (177)^2}$ = **238 units or 238,000 km from Earth**.

Note: The actual answer is 324,600 km when more accurate modeling is performed in 3-dimensions. The asteroid is off-set by an additional +221,000 km in the 'Z' direction.