

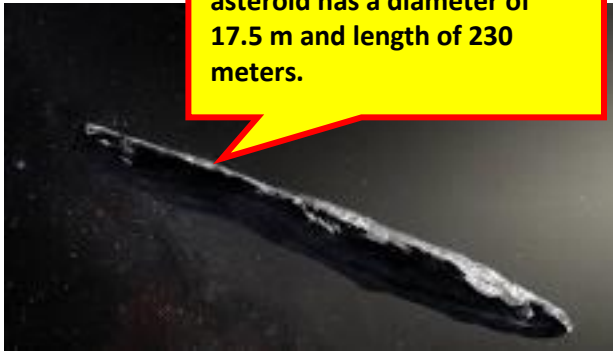
CENTRIPETAL FORCE & ENERGY

Units 10,11,14

Dr. John P. Cise, Professor of Physics, Austin Com. College, Austin Tx., & NYTimes Nov. 22, 2017 by Dennis Overbye

An Interstellar Visitor Both Familiar and Alien

This cylindrical shaped asteroid has a diameter of 17.5 m and length of 230 meters.



INTRODUCTION: Goal of this application is to find speed of this asteroid Oumuamua as it emerges from being slingshotted out of our solar system (see graphic below left). It entered our solar system at 40,000 mph. But, gained some Energy (200×10^{14} J) from the sun's gravitational field.

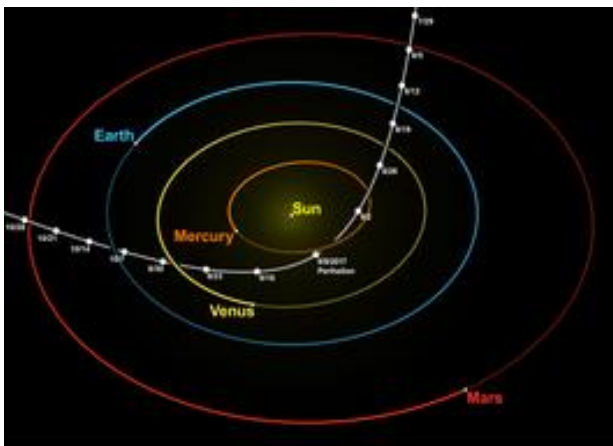
QUESTIONS: (a) Find the volume in m^3 of this cylindrical shaped asteroid. (b) The density of typical asteroids is $2000 \text{ kg}/\text{m}^3$. Find mass of this asteroid Oumuamua?, (c) Convert 40,000 mph to ft./s. ? (d) Find the kinetic energy of Oumuamua as it entered our solar system at 40,000 mph? (e) If this asteroid gained 200×10^{14} J of energy by being slingshotted around the sun, find its speed as it leaves sun Solar system?

See more below

A Glimpse of Oumuamua

Astronomers have discovered a passing rock from another star — the first interstellar asteroid. This fall, the galaxy came calling in the form of a small reddish cigar-shaped object named Oumuamua by astronomers based in Hawaii. They discovered it in October, **careening through the solar system at 40,000 miles an hour**, an interstellar emissary from points unknown. (Oh-moo-a-moo-a), Hawaiian for “scout” or “messenger,” was not here long. It was first noticed zooming out of the constellation Lyra on Oct. 19, about 20 million miles from Earth. By next May, it will already be passing Jupiter on its way out of the solar system. How Oumuamua got its shape is a mystery for now. Perhaps, Dr. Meech said, it was shot away from its home star by a supernova explosion. Or perhaps it was formed by a pair of objects that collided and stuck together. Stay tuned. Where did it come from? Dr. Meech said the astronomers were initially excited when the orbit appeared to point to the brightest star in Lyra, Vega, which is known to have a debris disk. It would have taken the object about 600,000 years to get here from there, astronomers estimated. The fact that Oumuamua was traveling at about the same speed relative to the sun as other nearby stars suggests that this is the asteroid's first encounter with a new star system. Still, the authors write in Nature, “The possibility that Oumuamua has been orbiting the galaxy for billions of years cannot be ruled out.” Where it's going is equally in the dark. **Like the Voyager spacecraft slingshotted around Jupiter, Oumuamua will**

leave the sun with more energy and heading in a different direction, Dr. Meech said.



HINTS: $60 \text{ mph} = 88 \text{ ft./s.}$, $m = (\text{density}) V$,
Vol. of cylinder = $A L = \pi R^2 L$, $L = \text{length}$, $K = \frac{1}{2} m v^2$
 $W = \Delta K + \Delta U$

ANSWERS: (a) $V = \sim 221,285.93 \text{ m}^3$, (b) $m = 4.42 \times 10^8 \text{ kg}$.
(c) $V_1 = 17.88 \times 10^3 \text{ m./s.}$, (d) $K_1 = 706.54 \times 10^{14} \text{ J}$,
(e) $V_2 = 20.25 \times 10^3 \text{ m./s.}$

COMMENT: This gravity assist to increase speed of this asteroid happens by chance for this asteroid from outside our solar system. But, this slingshotted gravity assisted increase in speed is done frequently to increase speed of Spacecraft and redirect their trajectory.