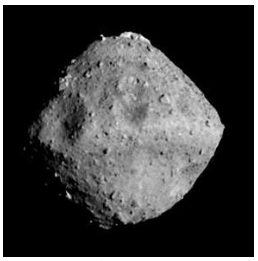
GRAVITY & ASTEROIDS

Unit 8 , Dr John P. Cise, Professor of Physics, Austin Community College, Austin Texas, USA jpcise@austincc.edu & NYTimes June 24, 2018 by Kenneth Chang, DEDICATED TO Dr. James Heath, Astronomer



Japan's Spacecraft Creeps Up on the Ryugu Asteroid

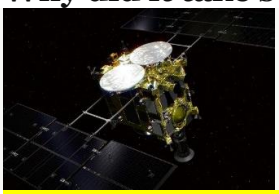
After a journey that started in 2014, the probe will reach the space rock on Wednesday to begin studying it for clues to the solar system's origins.

INTRODUCTION: In the Wikipedia/NASA data table (see lower left of this page)is listed the Diameter, weight(mg), & surface gravity ON asteroid Ryugu. Purpose of this application is to **find g (verify) on surface of Ryugu as 1/80,000 g(earth g) = ~ 1.225 X 10^{-4} m./s.^{2}**

A view of the asteroid Ryugu captured by the Hayabusa2 spacecraft on Sunday, from a distance of about 40 kilometers.

Here's the mission for Japan's Hayabusa2 spacecraft in a nutshell: Fly to a carbon-rich asteroid between the orbits of Earth and Mars, study it for a year and a half and then bring back some pieces for additional study on Earth. Like most space missions, that's much easier said than done. Launched in 2014, Hayabusa2 is just now approaching its target, Ryugu, an asteroid about half a mile wide. The Japanese astronomers studying it say it has the shape of a top or even an abacus bead. That's a big improvement from earlier in June when it sent back a picture taken at a distance of about 1,600 miles — the asteroid then was just three pixels across and looked like something drawn in the blocky style of Minecraft.

Why did it take so long to get there?



QUESTIONS: (a) Find weight mg of Ryugu in pounds?, (b) Find mass m of Ryugu in kg.?,(c) Find g On surface of Ryugu in units of m./s.^{2} ?

HINTS: 1 ton = 2000 lb., 0.454 kg./lb., G(gravitational constant = 6.67 X 10^{-11} N. m^2/kg.^{2} , mg = GmM/R^2 NEWTON'S 4TH LAW , GRAVITATIONAL

Hayabusa2 is powered by ion engines, which accelerate charged atoms of xenon with an electric field to generate thrust. Ion engines are a very efficient form of propulsion but not very powerful. The spacecraft used a flyby of Earth in December 2015 to accelerate and match its trajectory with the tilted orbit of the asteroid. Hayabusa is word for peregrine falcon. **When will the spacecraft reach Ryugu?** As of Monday, the spacecraft is about 15 miles away, and it is scheduled to arrive around Wednesday coming within 12.5 miles of the space rock. **(((It is currently creeping up to Ryugu at a relative velocity of about 4 inches per second)))** Asteroids are bits and pieces leftover from the disc of gas and dust that formed around the young sun and never quite coalesced into a planet. They contain some almost pristine compounds that help tell what the early solar system was like 4.5 billion years ago. Ryugu, as dark as coal, is a C-type, or carbonaceous, asteroid, meaning it is full of carbon molecules known as organics including possibly amino acids, the building blocks of proteins. Such molecules are not always associated with biology and can form from chemical reactions in deep space, but **asteroids could have seeded Earth with the organic matter that led to life.** "Up to now we know several top-shaped asteroids, but all of them have a short spin period around 3 hours," said Makoto Yoshikawa, the Hayabusa2 mission's manager. "The spin period of **Ryugu** is about 7.5 hours, so this issue is quite interesting from the point of science." This space rock was discovered in 1999 and not given a name until 2015. Ryugu is named after Ryugu-jo, or dragon's palace — a magical undersea palace in a Japanese folk tale.

What will it do once it gets there? If the spacecraft is able to keep its schedule, by the end of July, Hayabusa2 will descend within 3.1 miles of Ryugu's surface to measure the gravity field around the asteroid. In September or October, Hayabusa2 is scheduled to make its first "touchdown operation" on the asteroid. At that point, it may deploy one or more of the three tiny rovers it is carrying. It may also deploy a European-built lander then. At the end of 2019, Hayabusa2 is to leave the asteroid and head back to Earth. As it flies by in 2020, it'll drop off a capsule with the asteroid samples.

Physical characteristics	
Mean diameter	0.865 ± 0.015 km[3] 0.87 km[4] 0.90 ± 0.14 km[5] 0.92 ± 0.12 km[6] 0.980 ± 0.029 km[7] 1.13 ± 0.03 km[8]
Mass	496 × 10^6 tons[9]
Equatorial surface gravity	1/80,000 g[9]
Rotation period	7.627 ± 0.007 h[7][10]
Geometric albedo	0.037 ± 0.002[7] 0.042 ± 0.003[8] 0.047 ± 0.003[3] 0.063 ± 0.020[6] 0.07 ± 0.01[5] 0.078 ± 0.013[4]
Spectral type	SMASS = Cg[2] .

R = D/2 = .45 X 10^3 m

mg = 496 X 10^6 tons

ANSWERS: (a) Mg = 9.92 X 10^{11} lb., (b) M = 4.50368 X 10^{11} kg., g(surface of Ryugu) =~ 1.48 X 10^{-4} m./s.^{2}

COMMENT: g calculated is close to 1/80,000 g(earth) listed in NASA table at left. You can understand why the Ryugu spacecraft Is descending at JUST 4"/second with such very low gravitational acceleration.