GRAVITY & KINEMATICS

Units 4,5,8 Dr. John P. Cise, Professor of Physics, Austin Com. College, Austin Tx. jpcise@austincc.edu & New York Times, Sept. 22, 2017 by Kenneth Chang

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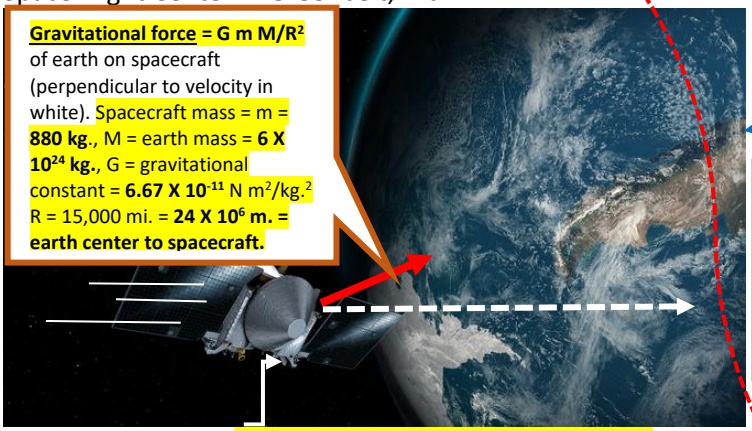
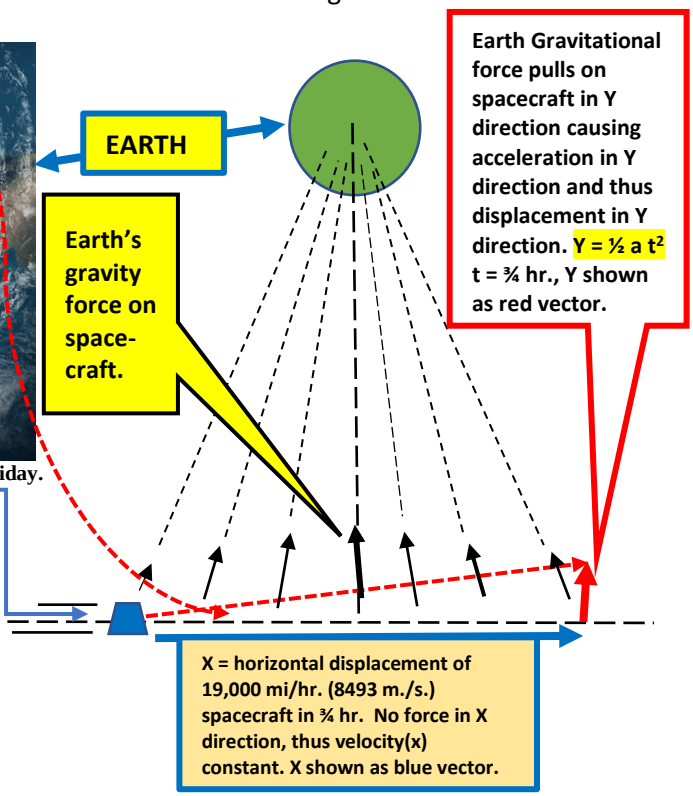
NASA's Osiris-Rex Spacecraft Is Headed

A NASA spacecraft, Osiris-Rex, is speeding toward Earth after a year looping around the sun**. On Friday afternoon, it will miss the planet by about 11,000 miles, zooming underneath our blue orb at 19,000 miles per hour,** passing over Australia and Antarctica. The near miss is deliberate. **The Earth's gravity will fling the spacecraft upward by about ((six degrees)) so that its trajectory will match the tilt of the orbit of its destination: a small near-Earth asteroid named Bennu.** "We're essentially stealing a bit of the Earth's momentum as we go by," said Michael Moreau, who leads Osiris-Rex's navigation team at NASA's Goddard Space Flight Center in Greenbelt, Md.



An artist's illustration of NASA's Osiris-Rex spacecraft flying by Earth on Friday.



INTRODUCTION: Purpose of this application is to validate this spacecraft is deflected by earth's gravitational pull by ~ 6° as stated in the article. Data is given in graphics.

QUESTIONS: (a) Find F (gravity force) on 880 kg. spacecraft? , (b)Find acceleration of spacecraft in Y direction as a result of earth's gravitational pull?, (c) Convert ¾ hr. to seconds? , (d) Find displacement Y caused by earth's pull over the ¾ hr. spacecraft was influenced appreciably by earth's gravity? NOTE: $V_o = 0$ (f) Find horizontal displacement X of spacecraft during the ¾ hr. it was significantly influenced by gravity force in Y direction. NOTE: No force in X direction, thus V = constant (f) Find angle of deflection (deviation from straight line path) of spacecraft? HINT: tan. Θ = Y/X , (g) Comment on Results?

ANSWERS: (a) F = ~ 611.4 N , (b) a = ~ 0.694 m./s.² , (c) t = 2700 s., (d) Y = 2.53 X 10⁶ m., (e) X = 22.93 X 10⁶ m. (f) Θ = ~ 6.3⁰ , (g) Amazing how close the deviation angle was validated. Yes! Osiris-Rex will successfully catch asteroid Bennu in a few years. Dr. Cise, Sept. 23, 2017. Then, in 2023 bring back to earth samples collected on asteroid Bennu's surface.

As a consequence, Earth's tilt will change ever so slightly, too small to be worth calculating. "It would be a very small number," Dr. Moreau said. Osiris-Rex — a shortening of Origins, Spectral Interpretation, Resource Identification, and Security, Regolith Explorer — was launched last year and circled the sun, returning for Friday's flyby. It is to arrive at Bennu in about a year. The asteroid periodically crosses Earth's orbit, and there's even a 1-in-2,700chance that it could hit Earth between 2175 and 2196. Scientists believe that Bennu, a dark asteroid about 500 yards in diameter, is full of carbon-rich molecules dating back to the birth of the solar system 4.5 billion years ago. Those molecules might have been the ingredients that led to life on Earth. Osiris-Rex will attempt to collect a few pounds of rock and dirt from Bennu by gently bouncing off the surface like a pogo stick and collecting material that it disturbs with a burst of nitrogen gas. It will bring the samples back to Earth in 2023 for closer study. For the flyby, there is no chance that Osiris-Rex, about the size of an S.U.V., will veer off course and slam into Earth. Spacecraft navigators have become adept at using precise flybys as slingshots to steer spacecraft through the solar system.