

CENTRIPETAL FORCE FROM GRAVITY

Unit 14 with gravity ideas from unit 8. Dr. John P. Cise, Professor of Physics, Austin Com. College, Austin Texas USA, jpcise@austincc.edu

How to Cover Rocket Blastoffs With an iPhone



Kenneth Chang, a New York Times reporter who covers space, in the World Trade Center Transportation Hub. He prefers the smaller iPhone SE to the new iPhone X.

By Kenneth Chang Nov. 22, 2017 How do New York Times journalists use technology in their jobs and in their personal lives? Kenneth Chang, who covers space for The Times, discussed the tech he's using. **What has stood out about how tech in the space race has changed in recent years?** The fundamentals of rocket science have not changed in the last 50 years. We don't have "Star Trek" transporter beams. We don't have antigravity. We don't have [electromagnetic rail guns](#). We don't have [space elevators](#). To escape the planet, it's still the explosive churning of fuel and oxygen, igniting the mixture and blowing the exhaust out of the engine nozzle. **Tech moguls like Jeff Bezos and Elon Musk are now involved in the space industry. Do you give the edge to Mr. Bezos or Mr. Musk and why?** The innovation in the space business has occurred in the business side. Take [Mr. Musk's SpaceX](#). His company's Falcon 9 rocket and Dragon capsule offer, more or less, the same capabilities as the decades-old Russian Soyuz. What Mr. Musk did was figure out how to build and launch the rockets at a lower cost. I like to joke that SpaceX is the Southwest Airlines of the rocket industry. In the last couple of years, SpaceX has also accomplished something new and different: landing the booster stage of a Falcon 9, refurbishing it and [launching it again](#). That has the potential for huge cost savings if rockets are not being thrown away after one flight. [Mr. Bezos' rocket company](#), Blue Origin, has a similar approach toward reusable rockets. Blue Origin has not yet finished its [New Glenn rocket](#), which will take payloads to orbit, but it has been testing and launching a smaller vehicle, known as [New Shepard](#), that will take space tourists on a short up-and-down ride to the edge of space.

INTRODUCTION: Satellites rotate around the earth and thus need a centripetal force [$m v^2/R$] from gravity [GmM/R^2] to change the direction of the satellites tangential velocity (v) vector. Equating $m v^2/R = G m M/R^2$ yields : $v = (G M_{\text{Earth}}/R)^{1/2}$ where G = gravitational constant = $6.67 \times 10^{-11} \text{ N m}^2/\text{kg}^2$, M = earth mass = $5.972 \times 10^{24} \text{ kg}$. $R = R_{\text{EARTH}} + h$ = earth radius + satellite height above earth, Where $R_{\text{EARTH}} = 3959 \text{ mi.}$, $h = 250 \text{ mi.}$

QUESTIONS: (a) Convert R_{EARTH} to meters?, (b) Convert h to meters?, (c) Find R (distance from center of earth to satellite location)? (d) Find required speed v to successfully orbit at 250 mile height? (e) Find v in mph?, (f) Does your result confirm statement at end of article?

HINTS: 1609.34 m./mi., 2.237 mph/ [m./s.]

ANSWERS: (a) $R_{\text{EARTH}} = 6.371 \times 10^6 \text{ m.}$, (b) $h = 0.405 \times 10^6 \text{ m}$

(c) $R = 6.776 \times 10^6 \text{ m}$, (d) $v \sim 7.667 \times 10^3 \text{ m./s.}$

(e) $v \sim 17,151 \text{ mph}$, (f) v computed came out close to stated velocity magnitude listed below at 17,000 mph. CLOSE



Mr. Chang preparing for work in his home in Jersey City. SpaceX,

he said, is good at showing video from its rockets. **Do you have a favorite space app or a piece of technology for covering space?** I don't use any space-specific apps. But the interconnectedness of everything today is awesome.

Early one morning a few years ago, I interviewed astronauts on the International Space Station while sitting at my kitchen counter. Just oldfangled technology: a landline telephone. But it's something that I wouldn't have imagined possible 20 years ago. It's easier than ever to connect Point A to Point B even when Point B

(((is 250 miles up, speeding at 17,000 miles per hour.)))