

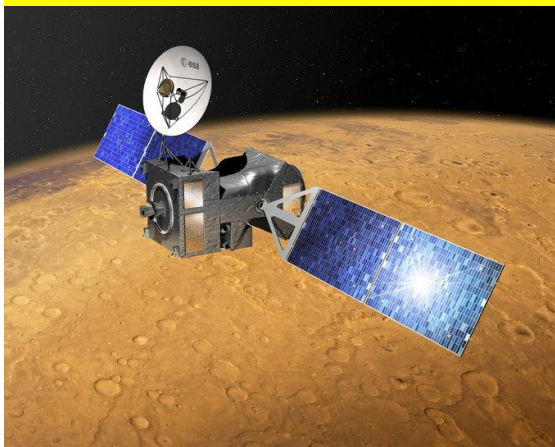
NEWTON'S 2ND LAW & KINEMATICS

Units 6,7,4,5 Dr. John P. Cise ,

Professor of Physics, Austin Com. College , 1212 Rio Grande St. Austin Tx. 78701 jpcise@austincc.edu &

New York Times March 13, 2016 by Kenneth Chang

Mars Mission Set to Launch to Study Gases and Storms



An artist's illustration of the European Space Agency's Trace Gas Orbiter at Mars

A Russian Proton rocket will carry the ExoMars 2016 spacecraft. Liftoff scheduled for Monday in Kazakhstan.

INTRODUCTION: From Wikipedia this Proton rocket has a weight of 1,529,600 lb. at liftoff & a liftoff thrust of 1,900,000 lb.

QUESTIONS: (a) Find mass of rocket at liftoff? (b) Make a free body diagram of forces on rocket at liftoff? (c) Apply Newton's 2nd law & set up working equation?

The [ExoMars](#) 2016 mission — **a collaboration between the European and Russian space agencies** — is scheduled to blast off from Kazakhstan on Monday. **The spacecraft, which consists of an orbiter that will measure methane and other gases in the Martian atmosphere and a lander to study dust storms,** will hitch a ride on top of a Russian Proton rocket that is expected to lift off at 3:31 p.m. Monday. **After a journey of seven months, the ExoMars spacecraft will arrive at Mars in October. Three days before arriving, the lander, named Schiaparelli after the 19th-century Italian astronomer Giovanni Schiaparelli, will separate from the orbiter.** It is to enter the atmosphere at 13,000 miles per hour and quickly decelerate on its way to settling down on the surface. The main objective of Schiaparelli is to demonstrate its landing system. (The European Space Agency's last attempt to land on [Mars](#) — the Beagle 2 spacecraft, which accompanied the Mars Express orbiter in 2003 — failed.) The Trace Gas Orbiter is to operate much longer, until at least 2022, circling Mars at an altitude of 250 miles. Its instruments will measure gases, like methane, water vapor and nitrogen. NASA's Curiosity rover also detected [a transient whiff of methane in 2014.](#) **The ExoMars spacecraft was originally to be launched by NASA, but tight budgets led NASA to back out in 2012, and the Russians stepped in.**

QUESTIONS(continued): (d) Find acceleration at liftoff? (e) Find distance traveled in first 20 s.? (f) Find V after 20 s.?

HINTS: $F_{NET} = m a$, weight = $m g$, $g = 32 \text{ ft./s.}^2$, $X = V_o t + \frac{1}{2} a t^2$, $V = V_o + a t$, 88 ft./s. = 60 mph

ANSWERS: (a) 47,800 slugs ,(b) _____, (c) _____ (d) $\sim 7.76 \text{ ft./s.}^2$, (e) $\sim 1,552 \text{ ft.}$, (f) $\sim 155.2 \text{ ft./s.}$ or about 105.8 mph