# Homework Set 19: Rocket Science
## Due Monday, November 27, 2023

### Problems From TM5

**1)** 9-54 A rocket starts from rest in free space by emitting mass. At what fraction of the initial mass is the momentum a maximum?

Start with the expression for the velocity of a rocket, find the momentum and maximize it.

**2)** 9-58 Consider a single stage rocket taking off from the Earth. Show that the height of the rocket at burnout is given by

$$y_b = ut_b - \frac{1}{2}gt_b^2 - \frac{mu}{\alpha}\ln\left(\frac{m_0}{m}\right)$$

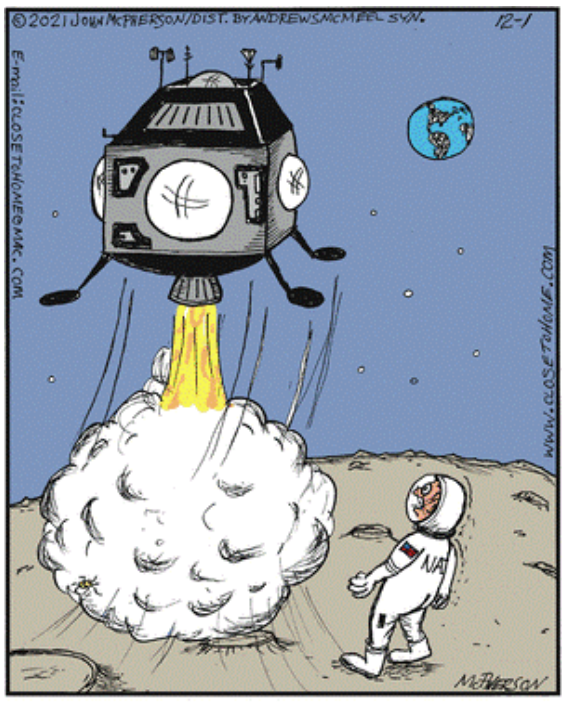
How much farther in height will the rocket go after burnout?

Keep in mind the facts that $\ln\left(\frac{m_0}{m}\right) = -\ln\left(\frac{m}{m_0}\right)$ and $\int \ln(ax)dx = x\ln(ax) - x$ (#299 in the blue book) and that it's a projectile after burnout.

**3)** 9-62 To perform a rescue, a lunar landing craft needs to hover just above the surface of the moon, which has a gravitational acceleration of *g/6*. The exhaust velocity is *2,000 m/s*, but fuel amounting to only 20% of the total mass may be used. How long can the landing craft hover?

Apply NSL to obtain a differential equation in m and t. The force a rocket produces is thrust that is given by the speed of the exhaust and the rate of change of the mass.

$$T = -u\frac{dm}{dt}$$




"For cryin' out loud! I PROMISE!
I won't eat the chili anymore!"