

Quiz 10/03Name grading key

The first stage of a Saturn V rocket had these parameters:

burn time = 165 s ; exhaust relative speed = 2,580 m/s ;

initial mass = 2,970,000 kg ; initial fuel mass = 2,160,000 kg .

The rocket is fired upward from the surface of the Earth.

Approximate $g = 9.8 \text{ m/s}^2$. Calculate the velocity when the first stage runs out of fuel.

$$m \frac{dv}{dt} = K v_{ex} - mg \quad \text{and} \quad K = -\frac{dm}{dt}$$

$$dv = v_{ex} \frac{dm}{m} - g dt$$

$$v = -v_{ex} \ln\left(\frac{m_{FIN}}{m_{INI}}\right) - g t$$

$$\begin{aligned} v &= -2580 \ln\left(\frac{810,000}{2,970,000}\right) - 9.8 \times 165 \\ &= 1735 \text{ m/s} \end{aligned}$$

(Taylor, Problem 3.11.) \Leftarrow Check the answer on page 753.

(Lecture of 9/28) \Leftarrow Study slide #6