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(1) $\Delta v = I_{sp} g_0 \ln M_0/M_f$

$7600 = 400 \times 9.8 \ln M_0/M_f$

$6.944 = M_0/M_f = \frac{M_{prop} + M_{payload}(+)}{M_{payload}(+) \text{ (extra)}}$

$6.944 M_{prop} = 5.944 M_{payload}(+)$

$=$

$\frac{M_{prop}}{M_0} = 5.944/_{12.8} \approx 23/50$

(2) $n = \frac{c\dot{m}}{m_0 g}$ $\qquad dm/dt = -\dot{m}$

a) $F_{net} = c\dot{m}/m_0 g - mg$

$m\,dv/dt = c\dot{m} - mg = n m_0 g - mg$

$\int_0^v dv = \frac{n m_0 g}{\dot{m}} \ln(M/M_0) - g/\dot{m}\,(m - M_0)$

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b.) $\frac{dx(t)}{dt} = -gt - \frac{m_0 g}{\dot{m}} \ln\left(\frac{m_0 - \dot{m}t}{m_0}\right)$

$x = -gt^2/2 - \frac{m_0 g t}{\dot{m}} + \frac{n\, m_0 g}{\dot{m}^2}(m_0 - \dot{m}t)\ln(u)$

d.) Signifies abt the ~~Earth~~ thrust & speed of Exhaust, provided to rocket (by ejected gases)

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(3) $\Delta v = 8000\ m/s$

$V_e = 4500\ m/s$

$\Delta v = -V_e \times \ln\left(\frac{M_f}{M_o}\right)$

$8000 = 4500 \ln\left(\frac{M_o}{M_f}\right)$

$1.78 = \ln M_o/M_f$

$M_o = e^{1.78} M_f \approx 5.93 M_f$

$M_{prop} + M_{pay} + M_{rocket} = 5.93\,(M_{pay} + M_{rocket})$

$4.93\,(\underbrace{M_{pay} + M_{rocket}}_{x}) = M_{prop}$

$4.93x = M_o - x$

$x = M_o/5.93$

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$$\lambda = \frac{M_{rocket}}{M_{rocket} + M_{payload}}$$

$$\Delta v = I_{sp}\, g_0 \ln\left[\frac{M_{prop} + M_{pay} + M_{rocket}}{M_{pay} + M_{rocket}}\right]$$

$$\Delta V = I_{sp}\, g_0 \ln\left[\frac{M_0}{M_{pay} + M_{rocket}}\right]$$

$$(M_{pay} + M_{rocket})\lambda = M_{rocket}$$

$$M_{rocket} = \lambda\, M_{pay} / 1-\lambda$$

$$M_{pay} + M_{rocket} = \frac{M_{payload}}{1-\lambda}$$

$$\Delta v = I_{sp}\, g_0 \ln\left[\frac{M_0(1-\lambda)}{M_{payload}}\right]$$

$$M_0 = \frac{M_{pay}\, e^{\Delta V / I_{sp} g_0}}{(1-\lambda)}$$