Q1

$$\Delta v = V_e \ln\left(\frac{m_0}{m_g}\right)$$

$$\Delta V = I_s \, g_o \ln\left(\frac{m_0}{m_g}\right)$$

$$m_e = m_{mg} + m_u + m_{rocket}$$

$$\lambda = \frac{m_e}{m_{\text{propellant}}}$$

$$\Rightarrow \Delta V = I_{sp} \, g_0 \ln\left(\frac{1}{\lambda}\right)$$

$$\left\{ \lambda = e^{-\frac{\Delta V}{g_0 I}} = \lambda \right.$$

$$\boxed{\lambda = e^{-\frac{\Delta V}{I_{sp}}}}$$

$$\Delta v = I_{sp} g_0 \ln\left(\frac{m_g}{m_q}\right)$$

$$= V_e \ln\left(\frac{m_g}{m_v}\right)$$

$$\Rightarrow \frac{\Delta v}{I_{sp} g_0} = -\ln\left(\frac{m_g \, m_v}{m_r \, m_{vz}}\right)$$

$$\Rightarrow e^{-\frac{\Delta v}{g_0 \, g_e}} = 1 - \frac{m_g}{m_q}$$

$$\frac{m_q}{m_g} = 1 - e^{\frac{\Delta v}{I_{sp} g_0}} \, \frac{m_q}{m_g}$$

$$\eta = 1 - e^{\frac{\Delta v}{g \, m_q}} \Rightarrow 0.85$$