\[ \begin{align*}
1. \quad v &= -gt + uln \left( \frac{m_0}{m} \right) \\
2. \quad \frac{dy}{dt} &= -gt + uln m_0 - uln m \\
   &\Rightarrow y = -\frac{gt^2}{2} + uln m_0 t - \int uln m dt \\
   &\quad \frac{dm}{dt} = -\alpha \\
   &\Rightarrow \int dt = -\frac{dm}{\alpha} \\
   &\Rightarrow y = -\frac{gt^2}{2} + uln m_0 t + \frac{u}{\alpha} \int uln m \, dm \\
   &\quad y_t = -\frac{gt^2}{2} \left. \left[ uln m_0 t \right] \right|_0^t \\
   &\qquad + \frac{u}{\alpha} \left. \left[ uln m - m \right] \right|_0^{m_0} \\
   &\quad = -\frac{gt^2}{2} + uln m_0 t_t + \frac{u}{\alpha} \left[ uln m - m - m_0 m_0 + m_0 \right] \\
   &\quad m = m_0 - \alpha t_t \\
   &\Rightarrow t_t = \frac{m_0 - m}{\alpha} \\
   &\Rightarrow y_t = -\frac{gt^2}{2} + uln m_0 \left( \frac{m_0 - m}{\alpha} \right) + \frac{um}{\alpha} ln m
\end{align*} \]
\[ y_t = -\frac{gt^2}{2} + \frac{um \ln \alpha_m}{\alpha} - \frac{um \ln \alpha_m + um \ln \alpha}{\alpha} + u \left( \frac{m_0 - m}{\alpha t} \right) - \frac{um \ln \alpha_m}{\alpha} \]

\[ = ut_t - \frac{gt^2}{2} - \frac{um \ln \left( \frac{m_0}{m} \right)}{\alpha} \]

c) \( u_i = u_t, \quad u_f = 0, \quad y = y_{extra} \)

\[ 0 = u_t^2 - 2g y_{extra} \Rightarrow y_{extra} = \frac{u_t^2}{2g} \]

2 a) \( w_0 = \sqrt{\frac{q}{l}} = \sqrt{\frac{9.8}{0.7}} = 3.74 \text{ rad/s} \)

6) \( E = \frac{1}{2} kA^2, \quad A = 0.03 \times 0.7 = 0.021 \text{ m} \)

\[ k = \frac{9}{l} \quad \Rightarrow \quad k = \frac{mg}{l} = \frac{0.4 \times 9.8}{0.7} = 5.6 \text{ N/m} \]

\[ \Rightarrow (E = 0.0012348 \text{ J}) \]

\( A(t) = A_0 e^{-\beta t} \)

6) \( E(0) = \frac{1}{2} kA_0^2 \)

\( E(t) = \frac{1}{2} kA_0^2 e^{-2\beta t} \)

\( \Delta E = E(0) - E(t) = \frac{1}{2} kA_0^2 \left( 1 - e^{-2\beta t} \right) \)

for small \( \beta \)

\( \Delta E = kA_0^2 \beta t = \frac{mg}{l} A_0^2 \beta t \)