1.

$$m\left(\frac{dv}{dt}\right) = mg - c(v)^2 \quad ; \quad v(0) = 0 \qquad \sim \frac{dv}{dt} = 0 \text{ @ } v_s$$

$$\frac{dv}{dt} = g - \frac{c(v)^2}{m}$$

Variables: v, t
parameters: g, c, m

$$\tilde{v} = \frac{v - v_r}{v_s} \qquad \tilde{t} = \frac{t - t_r}{t_s}$$

$-_r$ = reference value
$-_s$ = scaling factor

$v(0) = 0 \rightarrow v_r, t_r = 0$

$$\frac{dv}{dt} = \frac{d(\tilde{v} \cdot v_s)}{d(\tilde{t} \cdot t_s)} \longrightarrow \frac{v_s}{t_c}\frac{d\tilde{v}}{d\tilde{t}}$$

non-dim

$$m\frac{v_s}{t_s}\frac{d\tilde{v}}{d\tilde{t}} = mg - cv_s^2\tilde{v}^2 \qquad \left[\begin{array}{c} m\frac{v_s}{t_s} = mg \\ t_s = \frac{v_s}{g} \end{array}\right]$$

$$m\frac{v_s}{\frac{v_s}{g}}\frac{d\tilde{v}}{d\tilde{t}} = mg - cv_s^2\tilde{v}^2$$

— divide by mg

$$\frac{d\tilde{v}}{d\tilde{t}} = 1 - \frac{c}{mg}v_s^2\tilde{v}^2$$

— choose v_c to be terminal velocity

$$\frac{dv}{dt} = 0 = g - \frac{cv^2}{m}$$

$$v_c^2 = \frac{mg}{c}$$

$$\frac{d\tilde{v}}{d\tilde{t}} = 1 - \tilde{v}^2$$

- plot with Rung-kutta
- set $v = 0.95$
- check $v = 1 \rightarrow \frac{dv}{dt}$ should $= 0$