$$F = ma \tag{1}$$

$$a = \frac{dv}{dt} \tag{2}$$

$\text{F}_{\textbf{gravity towards center of planet}} = -m \cdot g$

$\text{F}_{\textbf{resisting gravity}} = m \cdot g$

$\text{F}_{\textbf{resisting gravity}} = m \cdot g \propto v^2$

$\text{F}_{\textbf{resisting gravity}} = m \cdot g = k \cdot v^2$

$\sum Forces = F_{\textbf{resisting gravity}} + F_{\textbf{resisting gravity}}$

$\sum Forces = k \cdot v^2 - m \cdot g$

$\text{m}\cdot\dfrac{dv}{dt} = k \cdot v^2 - m \cdot g$

$\int \dfrac{m}{m \cdot g - k \cdot v^2} dv = \int dt$

$\dfrac{-\ln\left(\dfrac{\sqrt{k} \cdot v - \sqrt{m \cdot g}}{\sqrt{k} \cdot v + \sqrt{m \cdot g}}\right)}{2\sqrt{m \cdot g \cdot k}} = t + c$

-ln $\dfrac{\sqrt{k} \cdot v - \sqrt{m \cdot g}}{\sqrt{k} \cdot v + \sqrt{m \cdot g}} = 2 \cdot t\sqrt{m \cdot g \cdot k} + c$

$e^{-\ln \dfrac{\sqrt{k} \cdot v - \sqrt{m \cdot g}}{\sqrt{k} \cdot v + \sqrt{m \cdot g}}} = e^{2 \cdot t\sqrt{m \cdot g \cdot k} + c}$

$\left(\dfrac{\sqrt{k} \cdot v - \sqrt{m \cdot g}}{\sqrt{k} \cdot v + \sqrt{m \cdot g}}\right)^{-1} = e^{2 \cdot t\sqrt{m \cdot g \cdot k}} e^c$

$\dfrac{\sqrt{k} \cdot v + \sqrt{m \cdot g}}{\sqrt{k} \cdot v - \sqrt{m \cdot g}} = c \cdot e^{2 \cdot t\sqrt{m \cdot g \cdot k}}$

$$\sqrt{k}\cdot v+\sqrt{m\cdot g}=ce^{2\cdot t\sqrt{m\cdot g\cdot k}}(\sqrt{k}\cdot v-\sqrt{m\cdot g})$$

$$\sqrt{k}\cdot v+\sqrt{m\cdot g}=\sqrt{k}\cdot v\cdot c\cdot e^{2\cdot t\sqrt{m\cdot g\cdot k}}-\sqrt{m\cdot g}\cdot c\cdot e^{2\cdot t\sqrt{m\cdot g\cdot k}}$$

$$\sqrt{k}\cdot v-\sqrt{k}\cdot v\cdot c\cdot e^{2\cdot t\sqrt{m\cdot g\cdot k}}=-\sqrt{m\cdot g}\cdot c\cdot e^{2\cdot t\sqrt{m\cdot g\cdot k}}-\sqrt{m\cdot g}$$

$$\text{v}\cdot(\sqrt{k}-\sqrt{k}\cdot c\cdot e^{2\cdot t\sqrt{m\cdot g\cdot k}})=-\sqrt{m\cdot g}\cdot c\cdot e^{2\cdot t\sqrt{m\cdot g\cdot k}}-\sqrt{m\cdot g}$$

$$\text{v}=\frac{-\sqrt{m\cdot g}\cdot c\cdot e^{2\cdot t\sqrt{m\cdot g\cdot k}}-\sqrt{m\cdot g}}{\sqrt{k}-\sqrt{k}\cdot c\cdot e^{2\cdot t\sqrt{m\cdot g\cdot k}}}$$

Since the object was released from rest, the initial velocity at $t=0$ is $v=0$. Therefore we can easily solve for c.

`At` $t=0$ `and` $v=0$

$$0=\frac{-c\cdot\sqrt{m\cdot g}\cdot e^{2\cdot t\sqrt{m\cdot g\cdot k}}-\sqrt{m\cdot g}}{\sqrt{k}-\sqrt{k}\cdot c}$$

$$\rightarrow\quad\frac{-\sqrt{m\cdot g}\cdot(c+1)}{\sqrt{k}\cdot(1-c)}$$

$$\rightarrow\quad c=-1$$

`So`

$$\text{v}=\frac{\sqrt{m\cdot g}\cdot e^{2\cdot t\sqrt{m\cdot g\cdot k}}-\sqrt{m\cdot g}}{\sqrt{k}+\sqrt{k}\cdot e^{2\cdot t\sqrt{m\cdot g\cdot k}}}$$

$$\text{v}=\frac{\sqrt{m\cdot g}\cdot(e^{2\cdot t\sqrt{m\cdot g\cdot k}}-1)}{\sqrt{k}\cdot(1+e^{2\cdot t\sqrt{m\cdot g\cdot k}})}$$

$$\lim_{t\to\infty}\frac{\sqrt{m\cdot g}\cdot(e^{2\cdot t\sqrt{m\cdot g\cdot k}}-1)}{\sqrt{k}\cdot(1+e^{2\cdot t\sqrt{m\cdot g\cdot k}})}=\frac{\sqrt{m\cdot g}\cdot\infty}{\sqrt{k}\cdot\infty}$$

$$\therefore\quad \text{As } t\to\infty\qquad v\to\frac{\sqrt{mg}}{\sqrt{k}}.$$