Solid sphere mass $m$, radius $R$ rolls with no slip up a ramp of angle $\Theta$. At base of ramp, $V_m = V_e$. What is $a$ and how far up ramp does it go before stopping?

No slip, $V_e = RW$, $\omega = \frac{V_e}{R}$

we know that it decelerates

so + $a$ is down ramp.

so + $a$ must be as shown.

$a = \frac{R}{L} \cdot a = \frac{a}{R}$

What gives $a$ + as shown, only $T$ about $CM$ of $F_s$ (static force) as shown

Solid sphere $I = \frac{2}{5} mR^2$, $\sum F_x = ma_x$

(+ down ramp) $ma_x = mg \sin \Theta - F_s$

$\sum F_{cm} = Ia_x$, $F_s R = Ia$

$F_s R = \frac{2}{5} mR^2 \frac{a}{R} \to F_s = \frac{2}{5} ma$

$ma_x = mg \sin \Theta - \frac{2}{5} ma_x$

$\frac{7}{5} ma_x = mg \sin \Theta \to a_x = \frac{5}{7} g \sin \Theta$

$a_x$ is constant

$x^2 = V_0^2 \cos^2 \Theta + \frac{2 \alpha x}{a} (x - x_0) - \frac{2 \alpha x}{2a} = \frac{2 \alpha x}{2a} = \frac{7 V_0^2}{10 g \sin \Theta}$

This is always ramp.

By energy $W_{nc} = 0$, $F_s$ always acts at a pt. that has $V = 0$

$E_i = E_f$

$E_s = K_e + U_{gf} = mg x \sin \Theta$

$E_i = K_i + K_{ei} = \frac{1}{2} I \omega_i^2 + \frac{1}{2} m V_0^2$

$\omega_i = \frac{V_0}{R}$

$= \frac{1}{2} \frac{2}{5} mR^2 (\frac{V_0}{R})^2 + \frac{1}{2} m V_0^2 = \frac{1}{5} m V_0^2 + \frac{1}{2} m V_0^2$

$= \frac{7}{10} m V_0^2$

$E_i = E_f = \frac{7}{10} m V_0^2 = mg x \sin \Theta$

$x = \frac{7 V_0^2}{10 g \sin \Theta}$