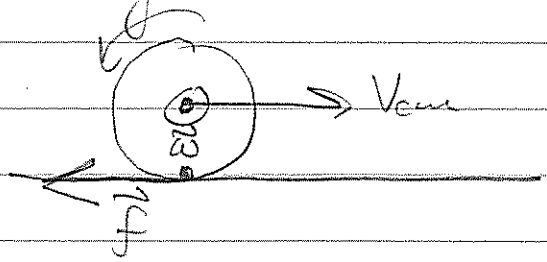
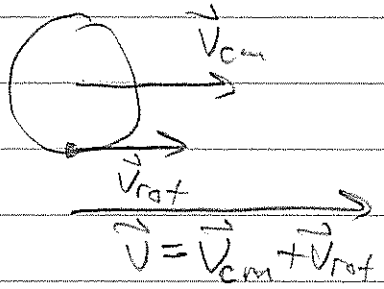
Rolling and Slipping

Bowling ball with backspin



$a_{cm} \neq \alpha R$

$v_{cm} \neq \omega R$



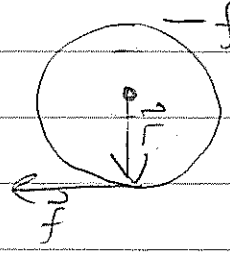
$\vec{f}$ opposes $\vec{v}$ at bottom of ball

$F_{net_x} = ma_x$

$-f = ma_x$

$\tau_{net,z}^{cm} = \frac{dL_{cm,z}}{dt}$

$-fR = I_{cm}\frac{d\omega_z}{dt}$



$\vec{\tau} = \vec{r} \times \vec{F}$

$\tau_z = -Rf$

ω_z decreases until $\omega = 0$ and then increases in $-z$ dir.

v_{cmx} decreases as well.

Eventually ω_z increasing in $-z$ dir matches the decreasing v_{cmx}.

When $\omega = \frac{V_{cm}}{R}$ then the ball will rotate without slidy and f will be 0.

$\left(\omega_2 = \frac{-V_{cmx}}{R} \right)$