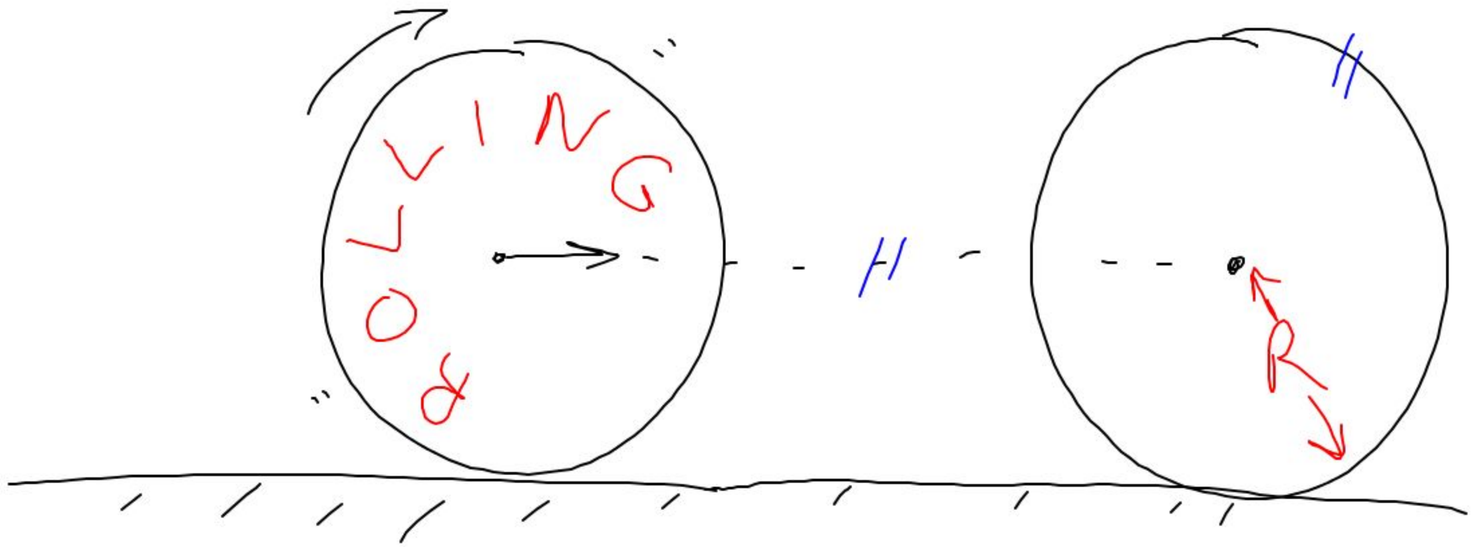


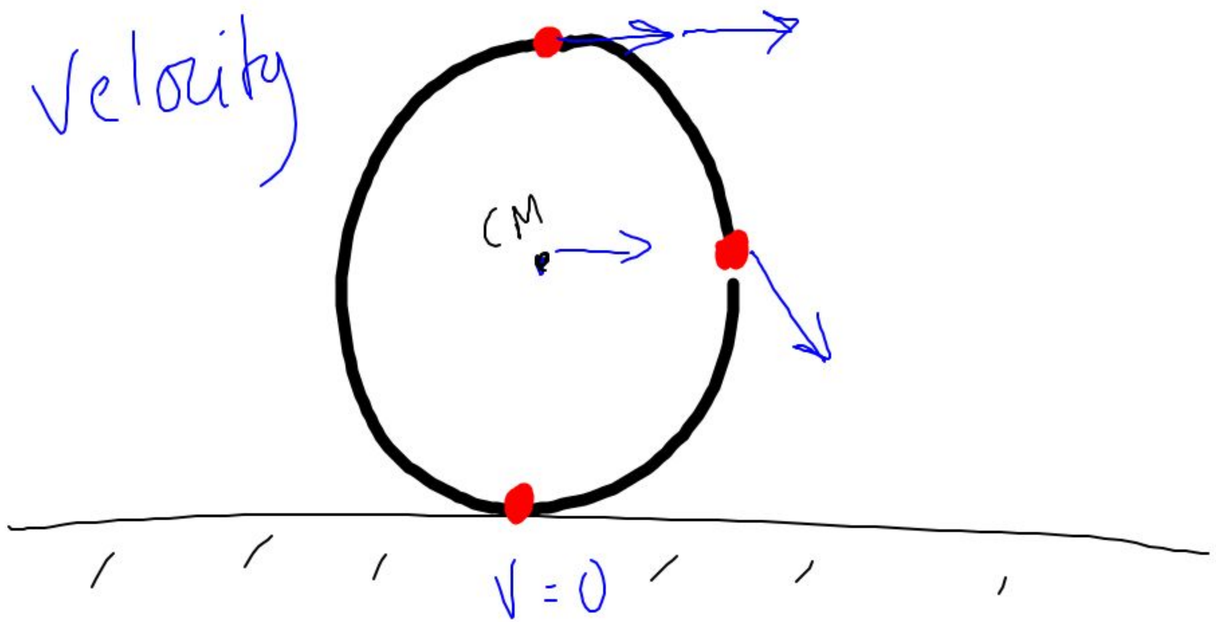
roll no slipping

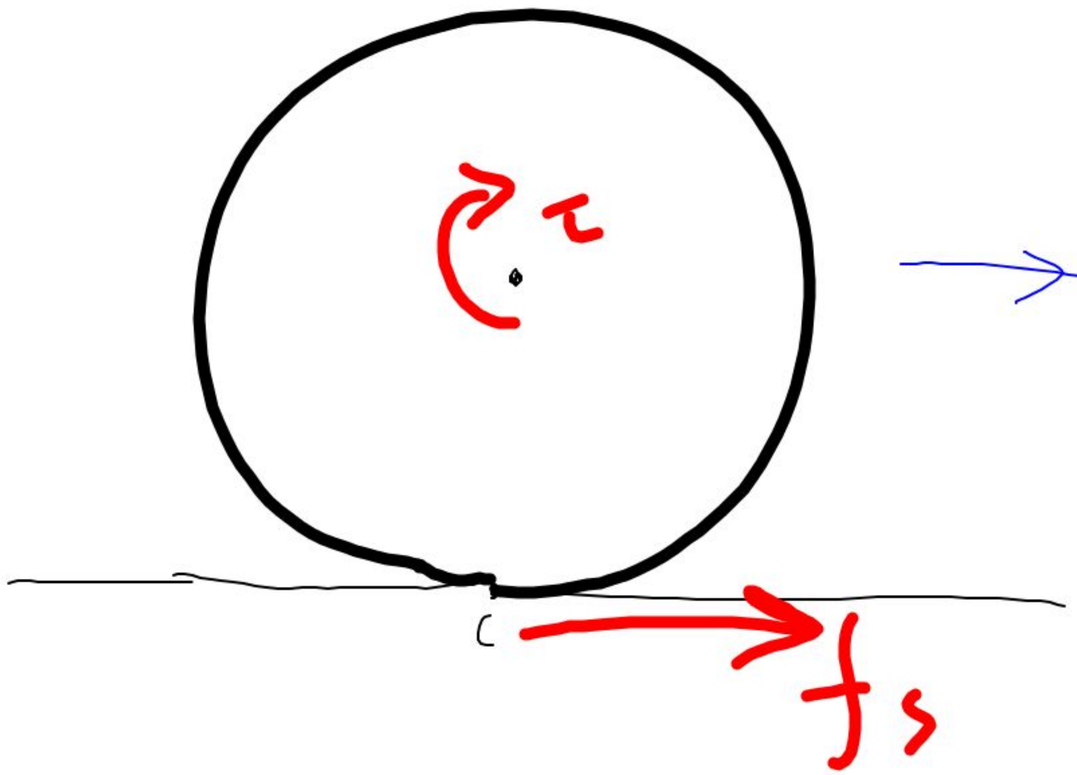
$$2\pi R = V_{CM}\, T$$

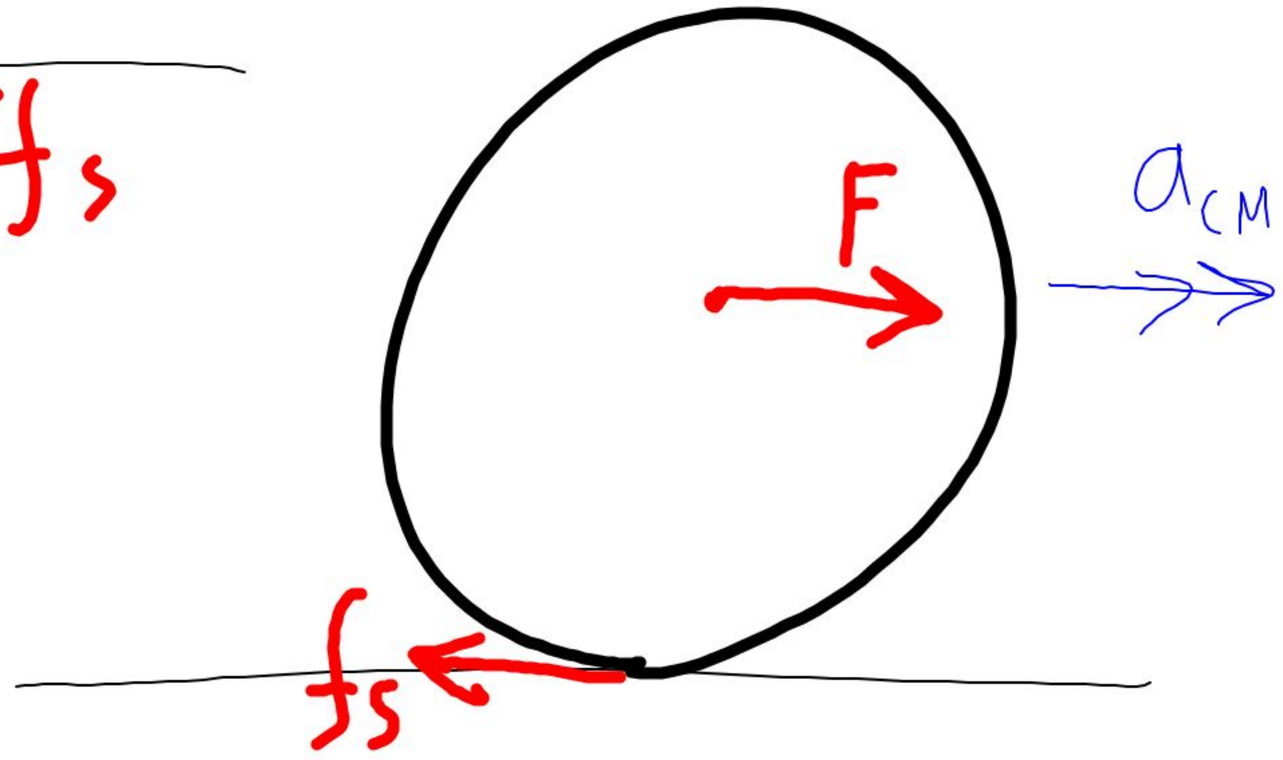
$$\left(\frac{2\pi}{T}\right) R = V_{CM}$$

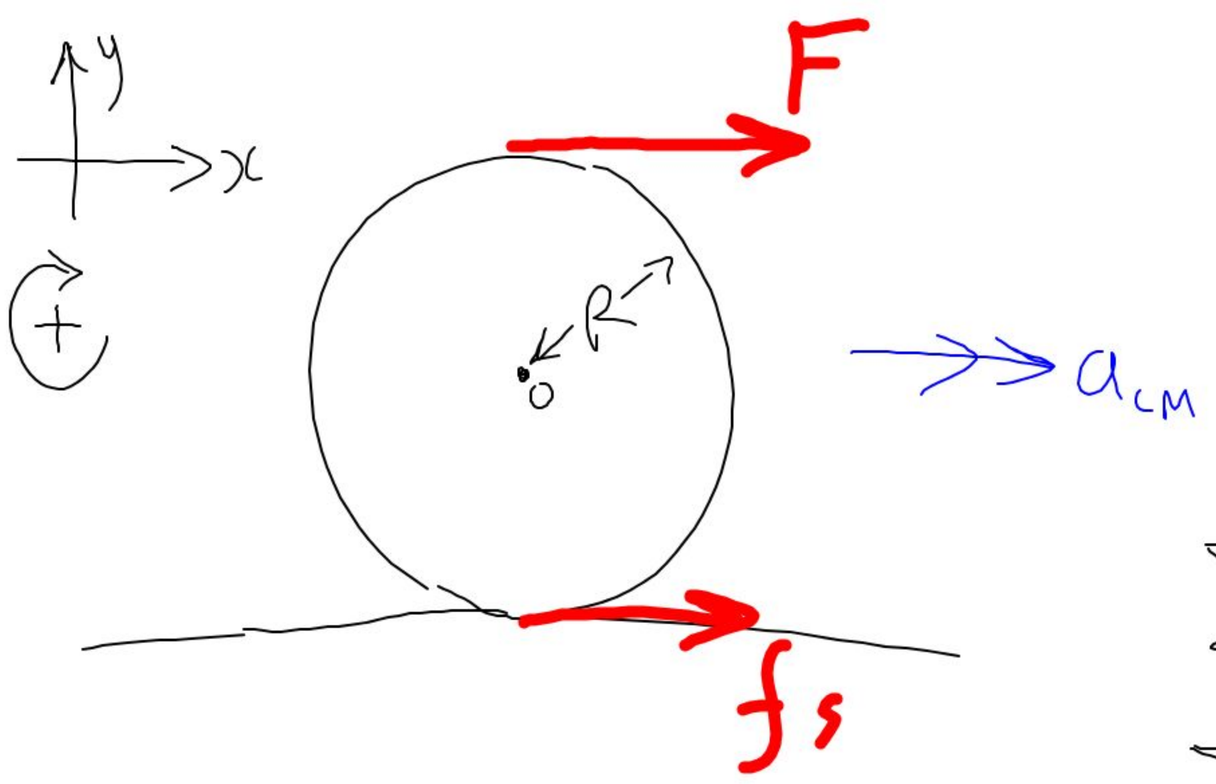
$$\boxed{\omega R = V_{CM}}$$

$$\boxed{\alpha R = a_{CM}}$$




τ
a_{cm}
C
f_s


F
a_{cm}
f_s



$$\sum \underline{\tau} = \underline{I}\,\underline{\alpha}$$

$$\sum \underline{F} = M\,\underline{a}_{cM}$$

$$\sum F_x = +F + f_s = M a_{cM}$$

$$\sum \tau_0 = +FR - f_s R = I\alpha \qquad \left(\tau = I\alpha\right)$$

Rolling $\omega R = v_{cM}$

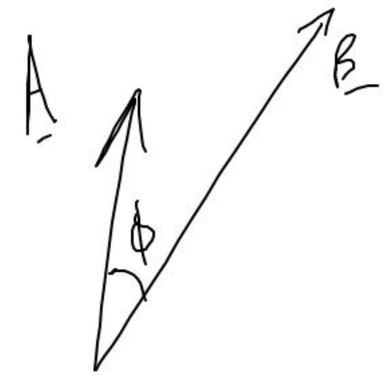
$\alpha R = a_{cM}$

$$\Rightarrow a_{cM} = \frac{F + f_s}{M} = R\,\frac{(FR - f_s R)}{I}$$

F_x, cylinder $I = \frac{1}{2}MR^2$

$$F + f_s = \frac{(F - f_s)}{1/2} \Rightarrow f_s = \frac{F}{3}$$

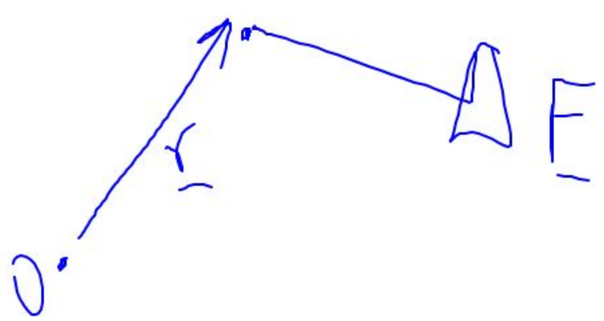
Cross product



$$\underline{A} \times \underline{B} = \underline{C} \qquad C = AB\sin\phi$$

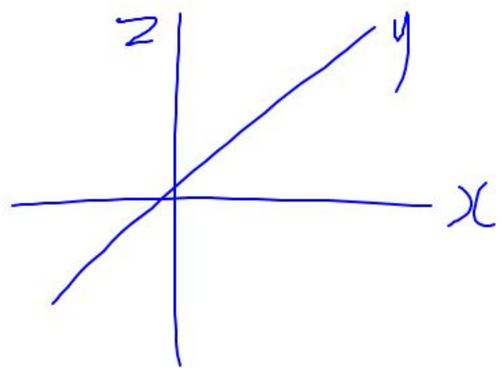
dir $\underline{C}$ = RHR

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



Ex, $\underline{r} = (0, -4, 3)\,m$

$\underline{F} = (2, 0, 0)\,N$

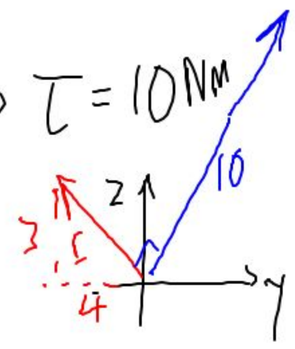


twist from $\underline{A}$ to $\underline{B}$

$\phi = 90°$

$r = 5m \Rightarrow \tau = 10\,Nm$

$F = 2N$



$\perp$ $\underline{r}$ length 10

$\underline{\tau} = (0, 6, 8)\,Nm$