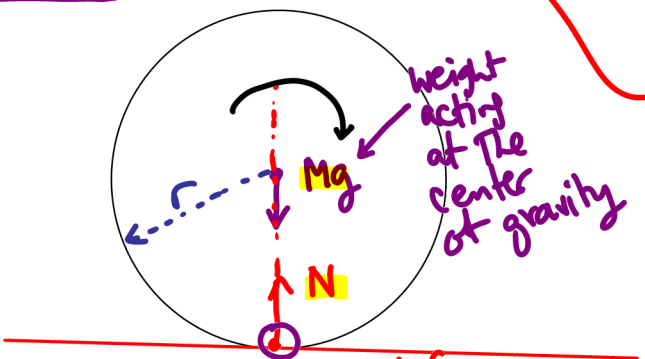
IDEAL



weight acting at the center of gravity

normal force acts at the contact point between the cylinder & the flat surface

does not deform!

rigid cylinder rotating on a flat (smooth) surface without slipping

- no friction
- no torque generated around the center of rotation (which is just the C.M.)

this cylinder will roll on the surface with constant ω forever

velocity of the center of mass of the cylinder.

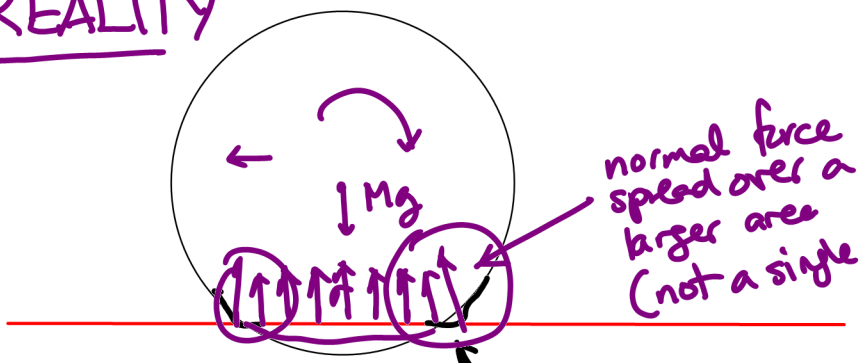
$V = \omega r$

acceleration of the C.M.

radius of the cylinder

$a = \alpha r$

REALITY



normal force spread over a larger area (not a single point)

normal force generates a torque that slows down the rotation

reality: the cylinder will deform when in contact with the flat surface

relative motion between the cylinder & flat surface

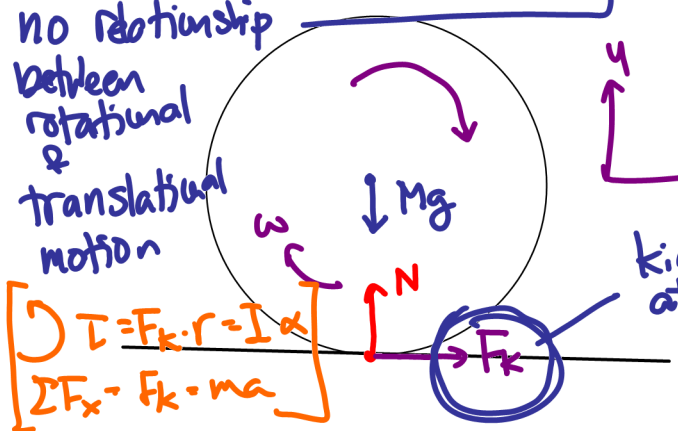
ROLLING RESISTANCE

also generates a net force that slows down the cylinder's center of mass.

RIGID

THE CYLINDER ROTATES WITH SLIPPAGE

no relationship between rotational & translational motion



$\circlearrowleft \tau = F_k \cdot r = I\alpha$

$\Sigma F_x = F_k = ma$

kinetic friction at the contact point

$F_k = \mu_k N$

- if cylinder rotates in the C.W. direction
  - ↳ F_k generates a torque in the CCW direction
    - ↳ net torque
      - ↳ rotation slows down
- net force in the x-direction
  - ↳ acceleration in the x-direction