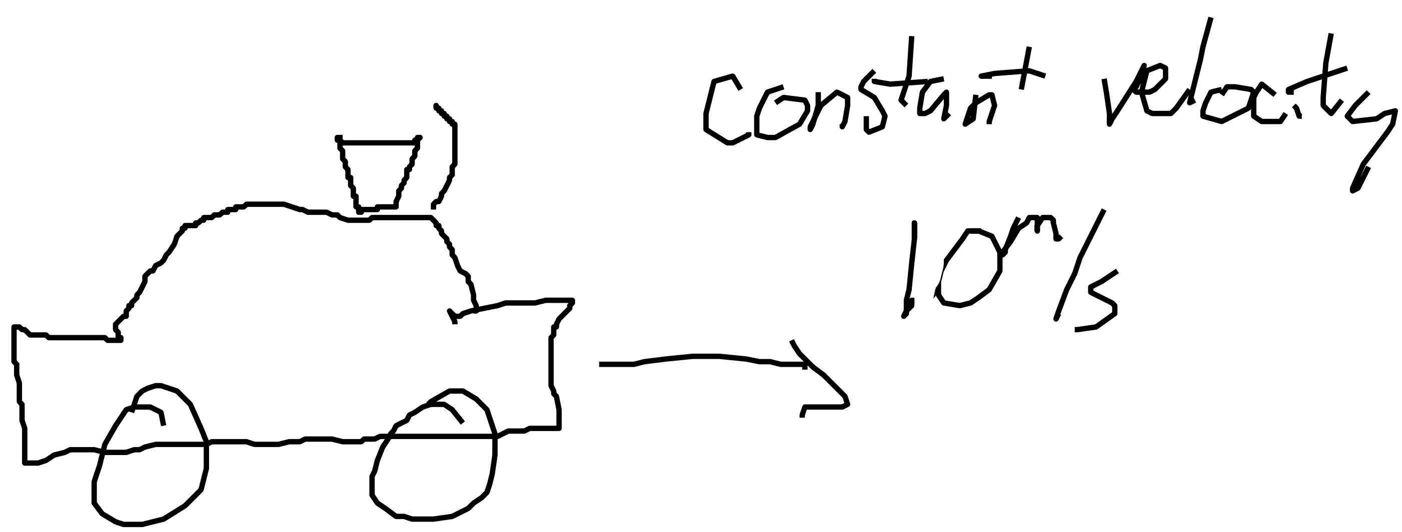
Newton's Second Law

$$\vec{a} = \frac{\vec{F}_{net}}{m}$$

$$\vec{F} = m\vec{a}$$



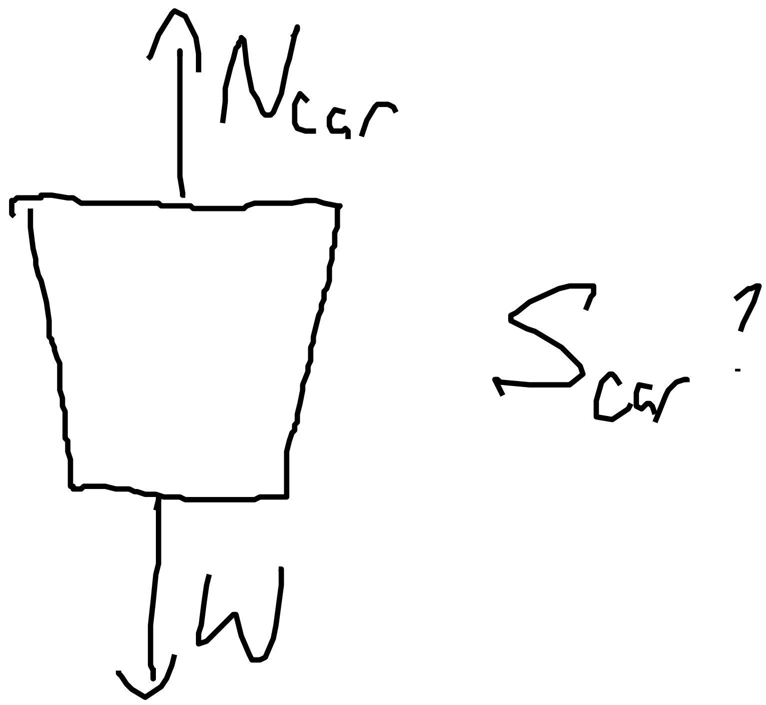
ignoring air resistance, what is the horizontal force on the coffee cup?

Static friction:

when there isn't sliding

Kinetic friction:

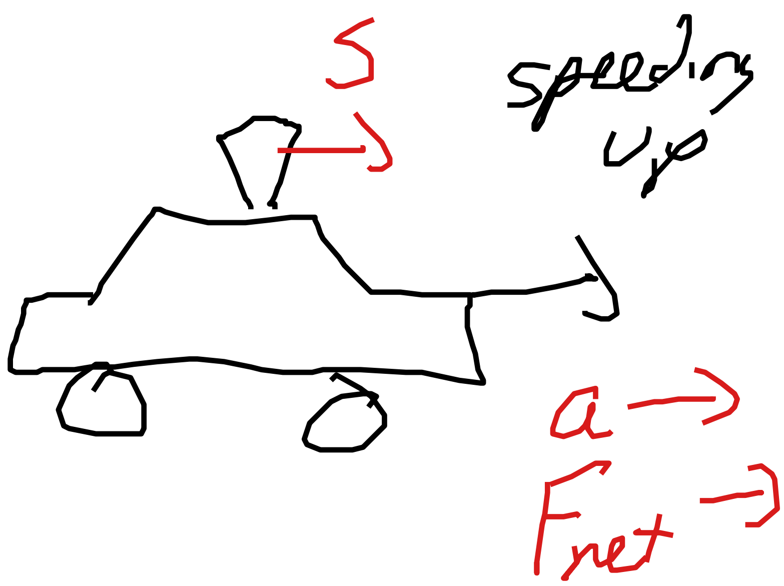
when there <u>is</u> sliding

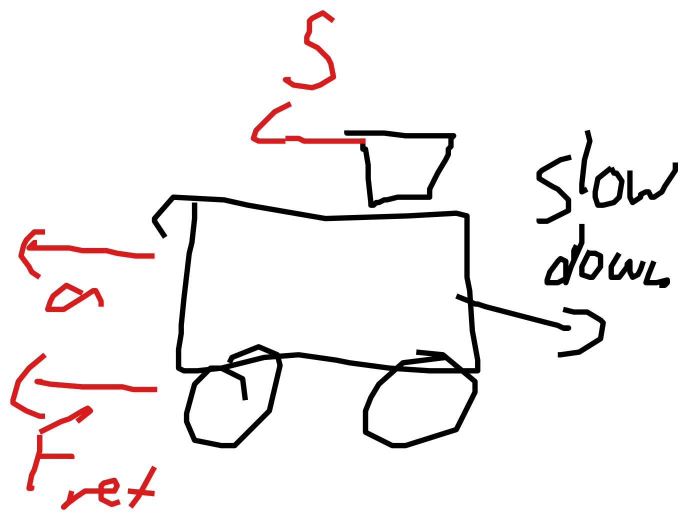


$$\vec{F}_{net} = m\vec{a} = 0$$

no acceleration

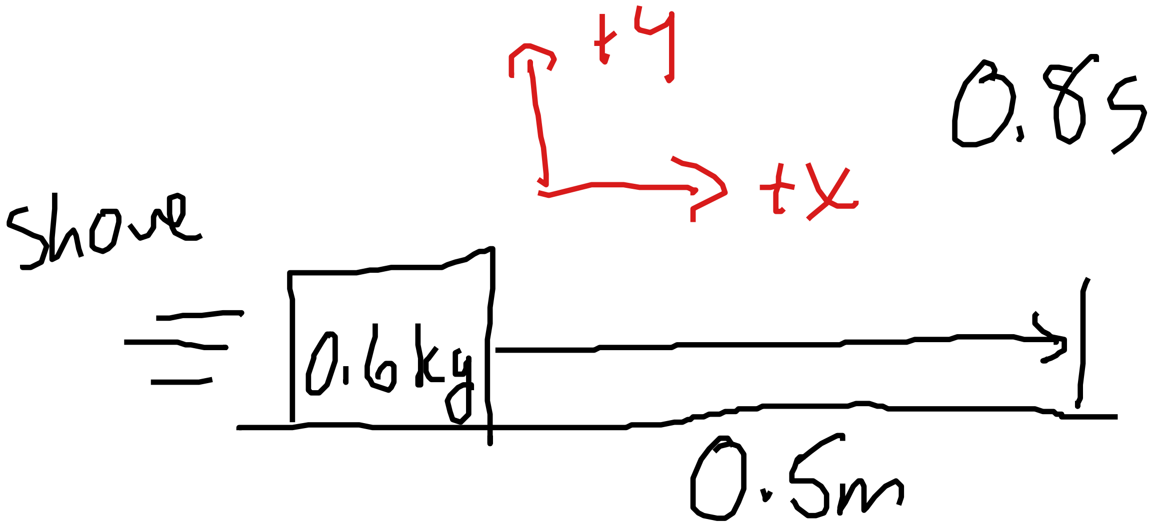
Cup is not accelerating so net force on it is zero. There are no other horizontal forces for S to balance, so $S = 0$ here.





Kinetic Friction

- $K = \mu_K N$ not adjustable
- sliding
- points opposite direction of motion (sliding)



What is μ_k between block and table?

Δx : +0.5m

V_i : DKDC

V_f : 0

a : NEED

Δt : 0.8s

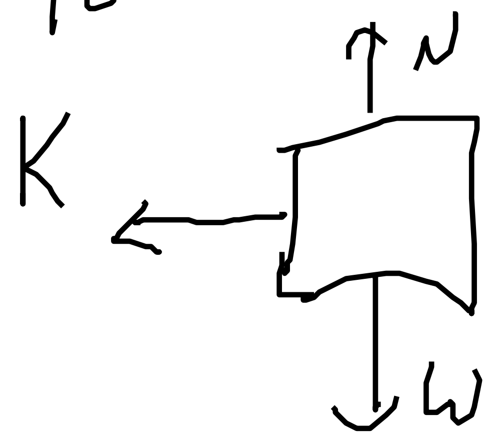
$\vec{F} = m\vec{a}$ is bridge between kinematics & forces.

$$\Delta x = V_f \Delta t - \frac{1}{2} a (\Delta t)^2$$

$$0.5 = 0 - \frac{1}{2} a (0.8)^2$$

$$a = \frac{1.0}{(0.8)^2} = 1.56 \, m/s^2$$

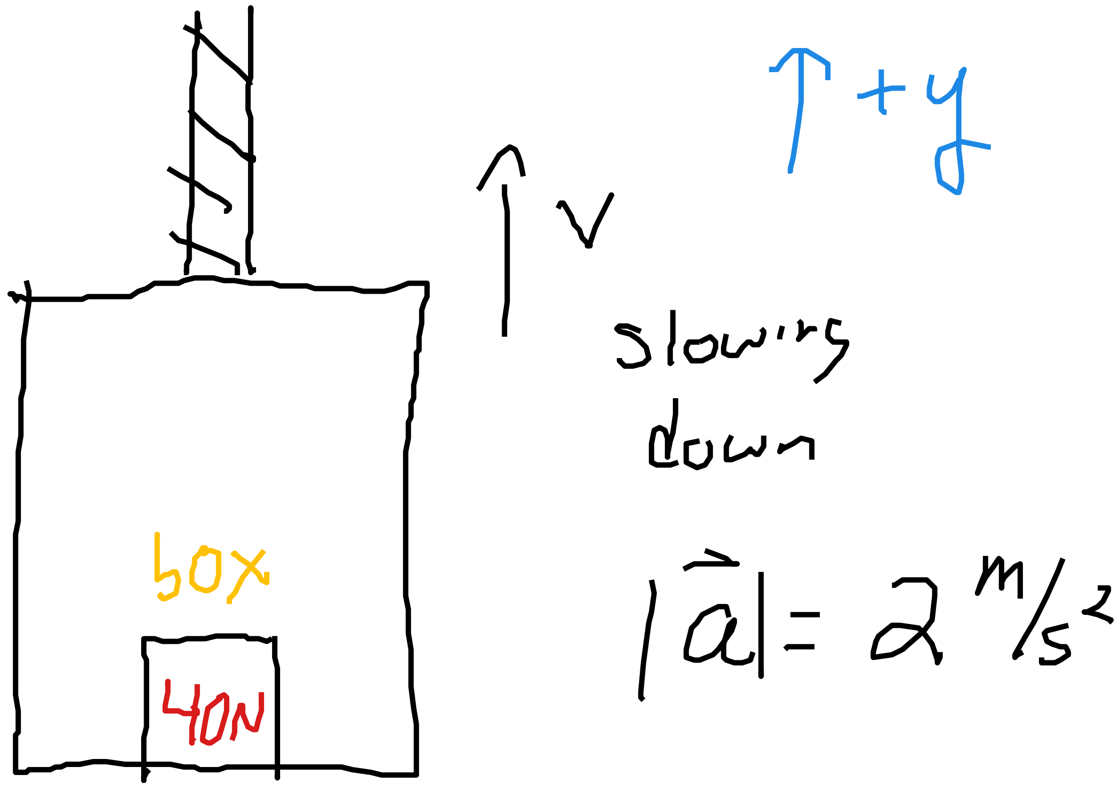
Force View



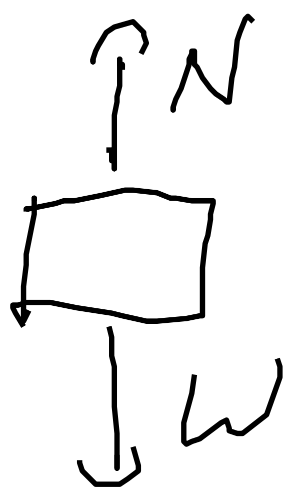
	x	y
weight	—	$-(0.6)(9.8)$
normal	—	$+N$
k. friction	$-\mu_k N$	—
$m\vec{a}$:	$(0.6)(-1.56)$	0

$$+\mu_k N = +0.936 \qquad N = 5.88$$

$$\mu_k = \frac{0.936}{5.88} = \boxed{0.16}$$



What forces are acting on the box?



Cable is not touching the block, so is not exerting a force.

Acceleration is not a force

Force Types

N, T, W, S, K

What is the normal force on the box?

$W = mg$

$40 = mg$

$m = \frac{40}{9.8}$

	y
weight	-40
normal, floor	$+N$
$m\grave{a}$	$-\left(\frac{40}{9.8}\right)2$

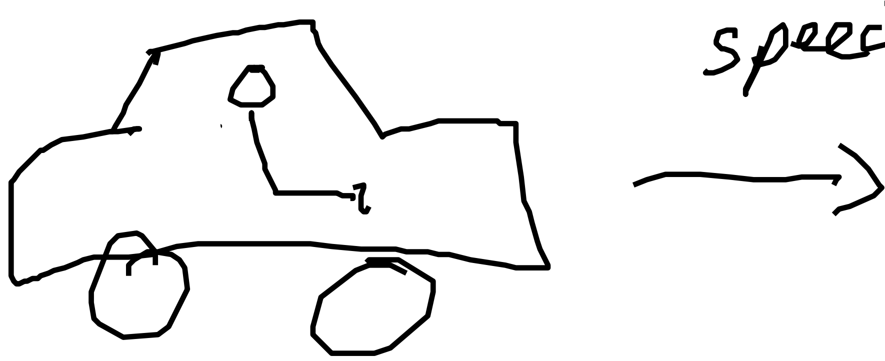
$-40 + N = -8.2$

$N = 40 - 8.2$

$= 31.8N$

Pseudo forces

Our bodies feel acceleration.



person has acceleration →

∴ net force on person →

∴ car pushes you forward

you feel pushed

into the seat

From drivers' perspective

driver is stationary relative to the car but the seat pushes them suddenly as if they are being "pushed back" into the seat

Pseudo force.

outside perspective

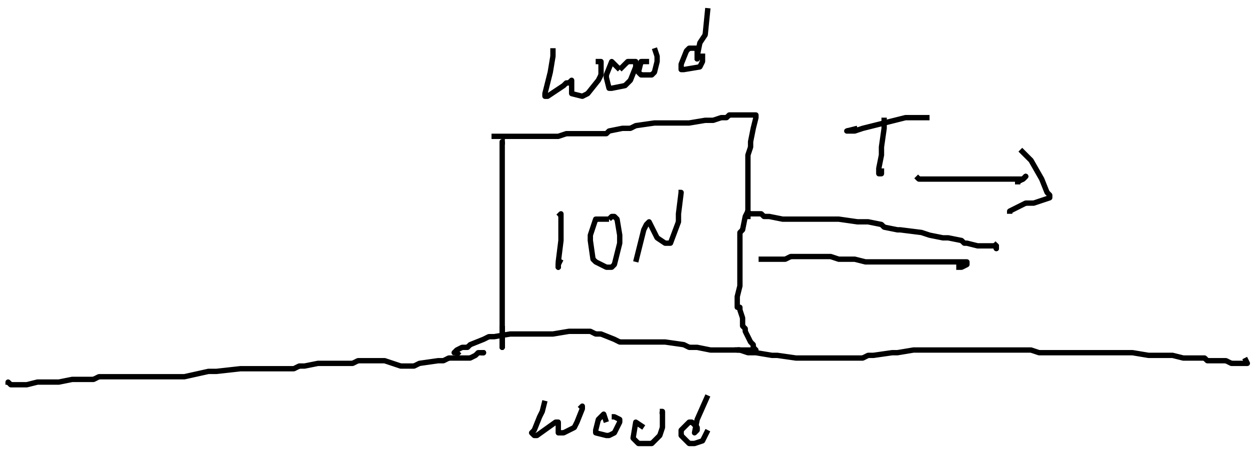
$$\vec{F}_{net} = \vec{F}_1 + \vec{F}_2 + \ldots + \vec{F}_n = m\vec{a}$$

drivers perspective: no acceleration

$$\vec{F}_1 + \vec{F}_2 + \ldots + \vec{F}_n - \underbrace{m\vec{a}}_{\text{pseudo force}} = 0$$

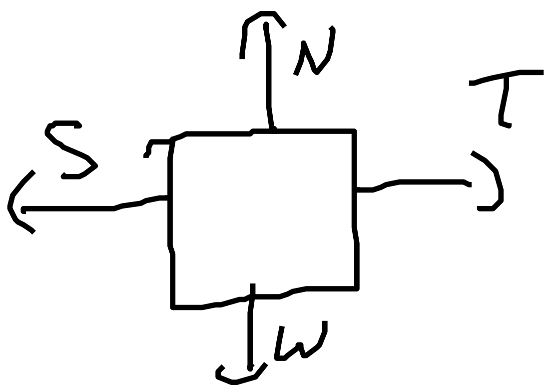
"mu"

μ_s is normally $>$ μ_k



$\mu_s = 0.5$

$\mu_k = 0.3$



not moving

$S = T$

$N = W = 10$

$$S \le \mu_s N$$

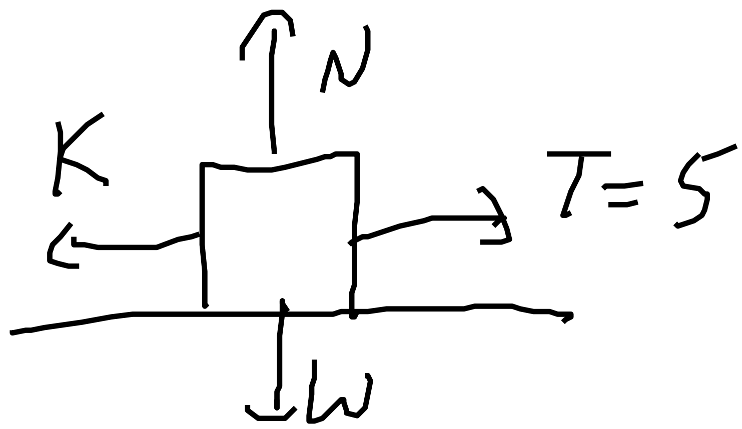
$$S \le (0.5)(10) = 5$$

So long as $S < 5$

$S = T$ end of story

but once $T = 5$

it slips



$N = W = 10$

$F_x = +5 - \mu_k N$

$5 - (0.3)(10)$

$5 - 3$

$= 2N$

$a_x = \frac{F_x}{m} = \frac{+2}{(10/9.8)}$

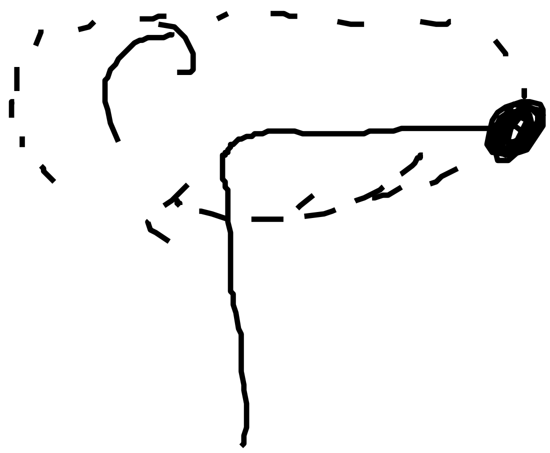
$a_x \approx +2 \; m/s^2$

When $\mu_k < \mu_s$ the block will jump forward as soon as static friction breaks.

"Centripetal Forces"

- forces that cause an object to move in a circle
- point towards the center of the circle if the speed is constant

"centripetal" is a direction "towards center" like "horizontal" or "vertical"



Spinning a ball around on a rope: tension is the centripetal force

T N W S K

N: amusement park ride where you're pressed against the wall

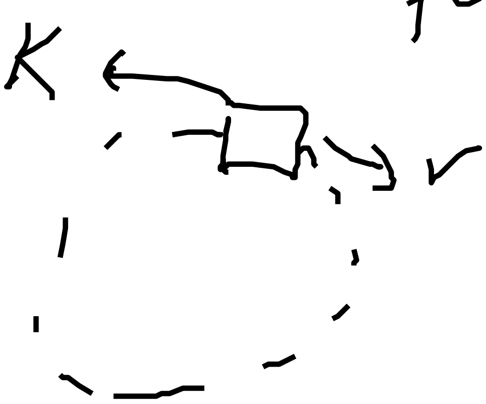
W: orbits (but not at room scale)

S: • offset dish in a microwave

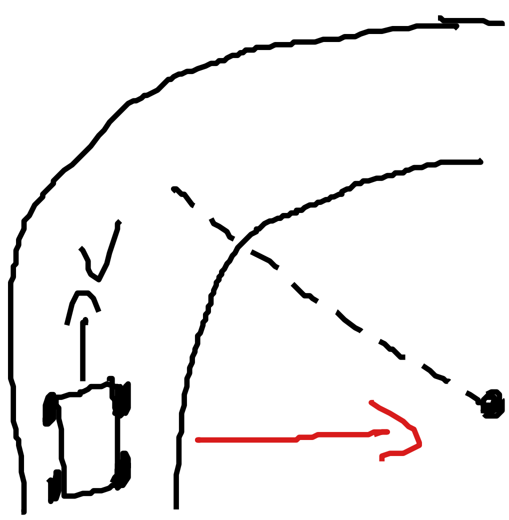
• walking in a circle

• driving in a circle

K: never(?) a centripetal force



Car driving around a corner



circular road

$r = 20m$

$v = 10\,m/s$

$$a_c = \frac{v^2}{r} = \frac{(10\,m/s)^2}{(20)} = 5\,m/s^2$$

toward center

$m = 1000\,kg$

$$F_c = ma_c = \frac{mv^2}{r} = 5000N$$

must be provided by static friction from the road but there's a limit on static friction

$$S_{road} \leq \mu_s N_{road}$$

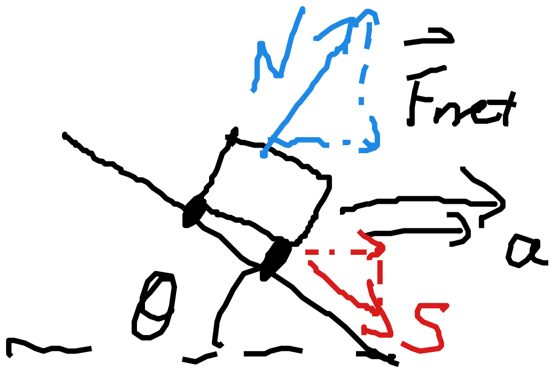
$= F_c$ → S_{road}; N_{road} ← $= mg$

$$\frac{\cancel{m}v^2}{r} \leq \mu_s(\cancel{m}g)$$

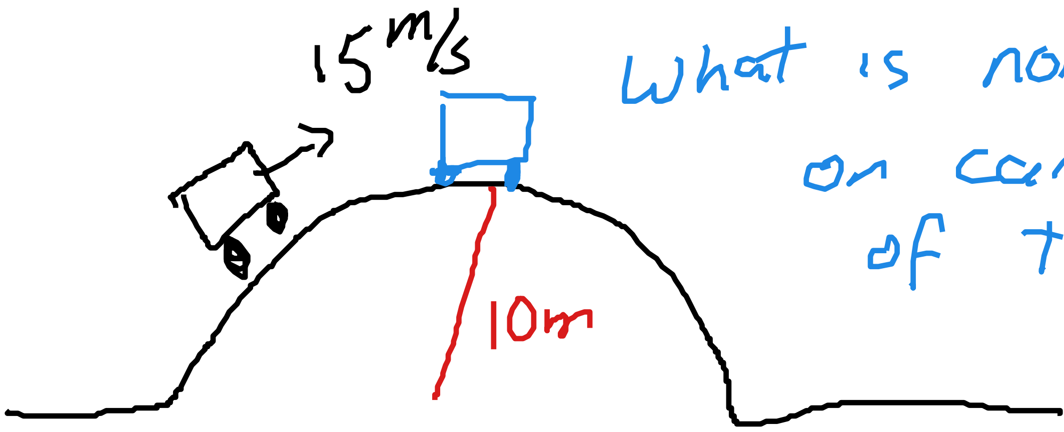
$$v^2 \leq \mu_s r g$$

$$(10\,m/s)^2 \leq \mu_s (20m)(9.8)$$

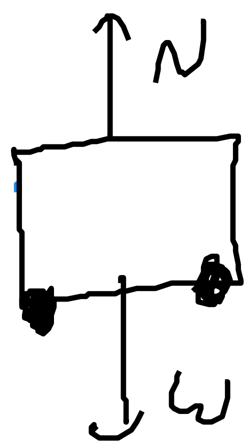
$$\mu_s \geq \frac{100}{20 \cdot 9.8} = 0.51$$



on a banked track like this, centripetal force comes from static friction and normal force



What is normal force on car at top of the bump?



$m = 1000\,kg$

weight $-mg$

normal $+N$

$m\vec{a}$: $(m)(-22.5)$

compare $g = 9.8\ m/s^2$

$a_c = \frac{v^2}{r} \downarrow = \frac{(15)^2}{10} = 22.5\ m/s^2$

$$-mg + N = -22.5m$$

$$N = mg - 22.5m$$

$$= (1000)(9.8) - (1000)(22.5)$$

$$= 9800 - 22500$$

$$= -12{,}700 \text{ N}$$

normal force must point down??

impossible

normal force must be a push

∴ false assumption –

car does not follow

the circular track