Today - Friction

2 Main cases:

(A) Slipping OR **(B) sticking**

(A) Slipping:
1. either $v \neq 0$ or $a \neq 0$
2. $F = \mu N$
3. $\hat{F}$ oppose motion ($\hat{v}$ or $\hat{a}$)

(B) sticking:
1. no relative motion
   $v = 0, \quad a = 0$
2. $F \leq \mu N$

F = friction force
N = normal force
μ = coeff of friction.

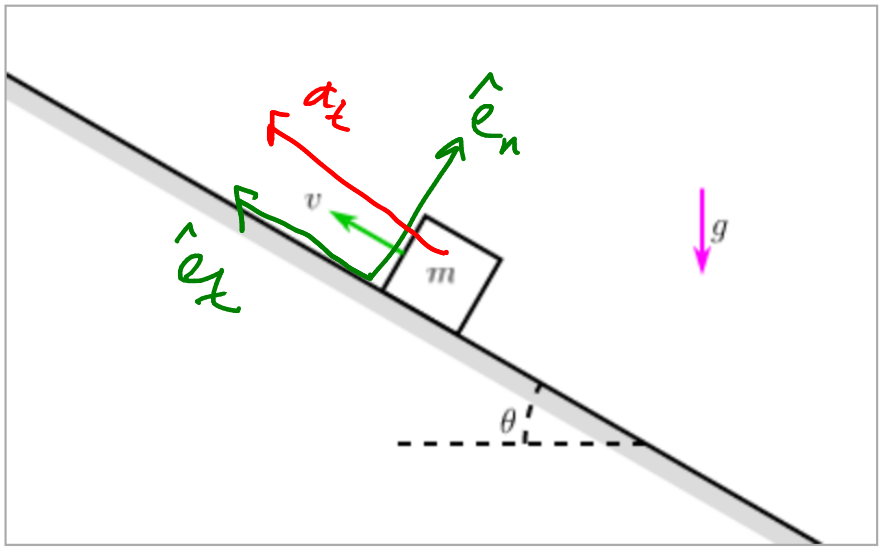
(C) Transition

$v = 0, \quad a = 0$

$F = \mu N$

#9-2. Acceleration of a block with friction (slopeFrictionAcc)

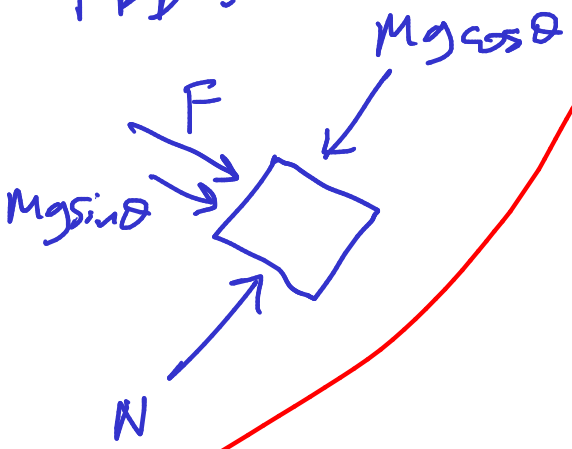
A block of mass $m = 8$ kg is sliding up a sloped ground with speed $v = 9$ m/s. The ground is at an angle of $\theta = 30^\circ$ from horizontal, the coefficient of friction between the block and ground is $\mu = 0.25$, and gravity $g = 9.8$ m/s^2 acts vertically.



What is the acceleration $\vec{a}$ of the block?

$\vec{a} =$ [ ] $\hat{\imath} +$ [ ] $\hat{\jmath}$ m/s^2

FBD:



A. Slip
B. Stick
C. transition

A. 1
B. 2
C. 3
D. 4
E. 5

$N = mg\cos\theta$

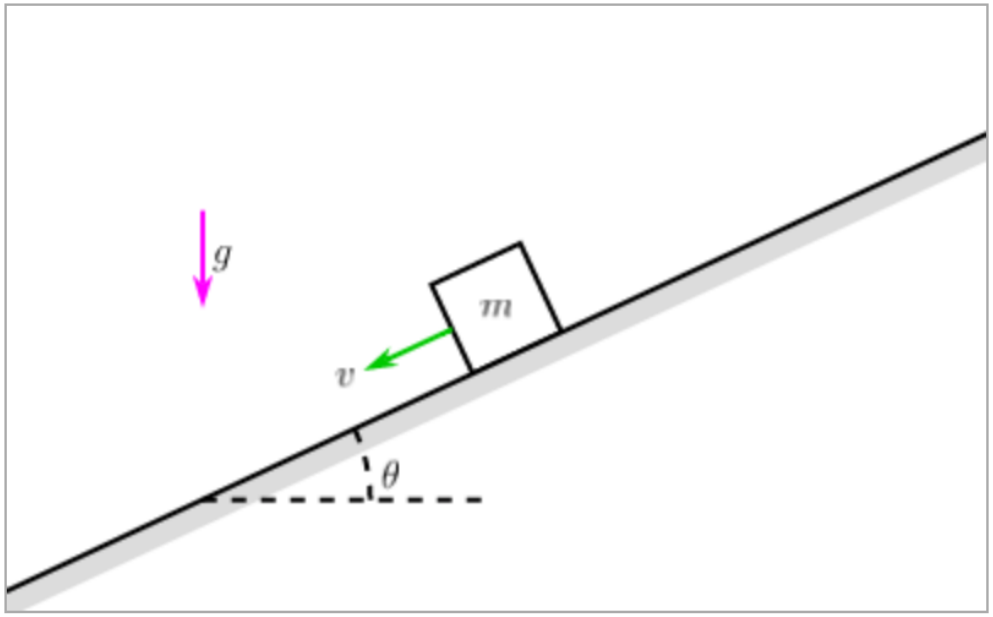
$F = \mu N$

CHECK!

A. $ma_t = F + mg\sin\theta$
B. $ma_t = -F + mg\sin\theta$
C. $ma_t = F - mg\sin\theta$
D. $ma_t = -F - mg\sin\theta$

#9-2. Acceleration of a block with friction (slopeFrictionAcc)

A block of mass $m = 8$ kg is sliding down a sloped ground with speed $v = 5$ m/s. The ground is at an angle of $\theta = 25^\circ$ from horizontal, the coefficient of friction between the block and ground is $\mu = 0.25$, and gravity $g = 9.8$ m/s^2 acts vertically.



What is the acceleration $\vec{a}$ of the block?

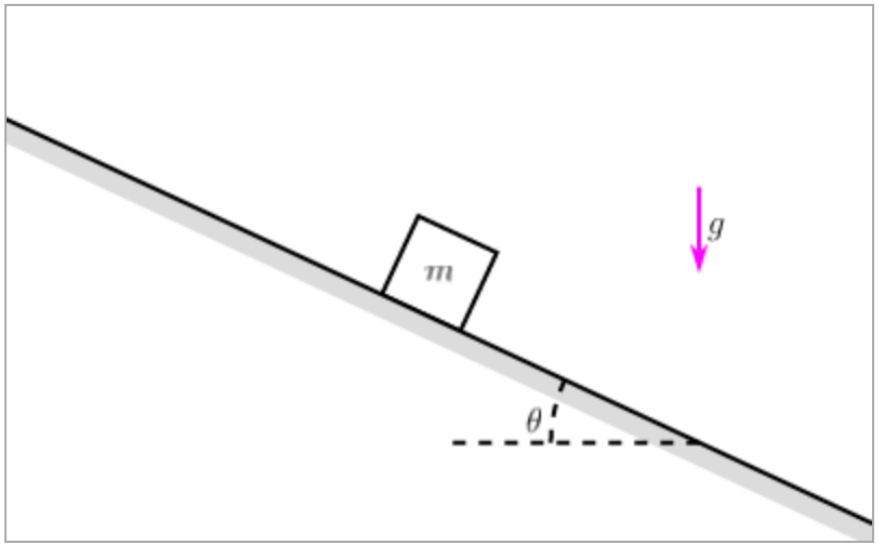
$\vec{a} =$ [ ] $\hat{\imath} +$ [ ] $\hat{\jmath}$ m/s^2

Given that $\vec{g}$ is down and $\vec{v}$ is down the slope:

A. $\vec{a}$ must be down the slope
B. $\vec{a}$ must be up the slope
C. $\vec{a}$ might be up or down the slope

#9-4. Minimum coefficient of friction on a slope (slopeFrictionMinCoeff)

A block of mass $m = 9$ kg starts at rest on a sloped ground. The ground is at an angle of $\theta = 25^\circ$ from horizontal and gravity $g = 9.8$ m/s^2 acts vertically.



What is the minimum coefficient of friction μ so that the block will not slide?

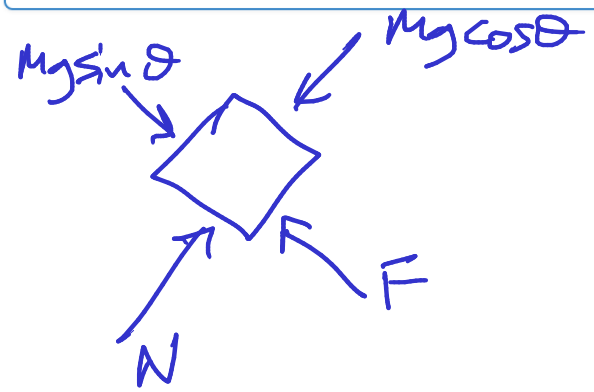
$\mu =$

* A. Slip
B. Stick
C. Transition

$V=0, a=0$

$F=\mu N$

A. $F=\mu N$
B. $a=0$
C. $v=0$
D. $F \leq \mu N$
E. $a \leq 0$



F, N, μ

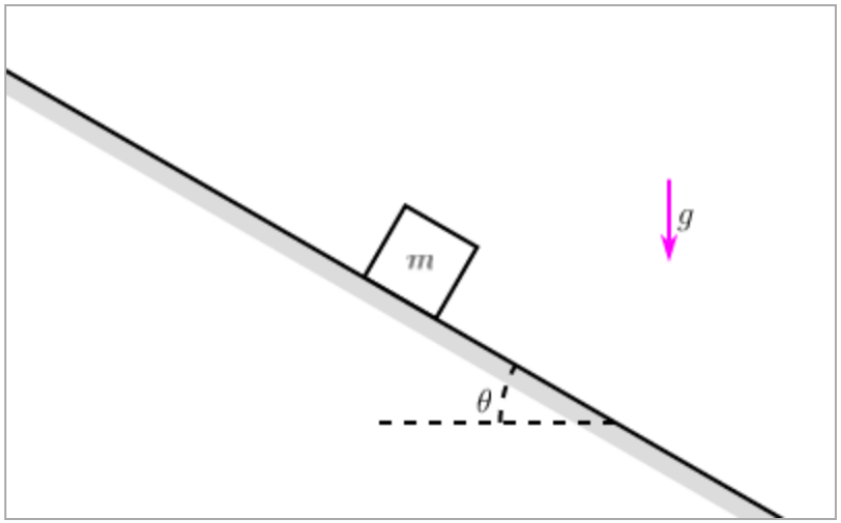
$\mu = \tan\theta$

μ depends on:

A. m, θ, g
B. m, θ
C. θ, g
D. m, g
E. θ

#9-9. Motion of a block with friction (slopeFrictionStick)

A block of mass $m = 3$ kg starts at rest on a sloped ground. The ground is at an angle of $\theta = 30^\circ$ from horizontal, the coefficient of friction between the block and ground is $\mu = 0.5$, and gravity $g = 9.8$ m/s^2 acts vertically.



What type of motion does the block experience?

- ○ The block sticks and does not move.
- ○ The block slips and accelerates down the slope.

— sticking
— slipping up
— slipping down.

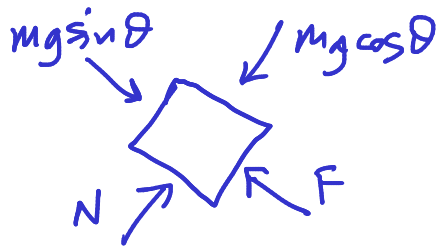
How many scenarios are kinematically consistent?

A. 1
B. 2
C. 3
D. 4
E. 5

Stick

→ assumed motion

$a = 0$



check: $|F| \leq \mu |N|$

$F = 14.7\ N$

$N = 25.5\ N$

$\mu N = 12.75 N$

$|F| \leq \mu |N|$ not true.

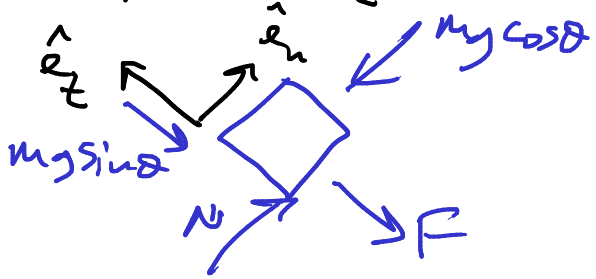
$m = 3 kg$, $\theta = 30°$, $g = 9.8 m/s^2$

$\mu = 0.5$

Slip up

→ assumed force

$\vec{F} = -\mu N \hat{e}_t$



check: $a \neq 0$

$\hat{F}$ opposes $\hat{a}$

$a = -9.15\ m/s^2\ \hat{e}_t$

$\vec{F} = -12.74 N \hat{e}_t$

$N = 25.5\ N$

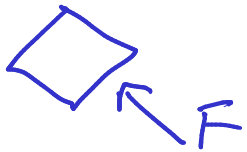
$a \neq 0$ ✓

$\hat{F}$ opposes $\hat{a}$

Slip down

→ assumed force

$\vec{F} = \mu N \hat{e}_t$



check: $a \neq 0$ ✓

$\hat{F}$ opposes $\hat{a}$

$a = -4.24\ m/s^2 \hat{e}_t$

$\vec{F} = 12.74 N \hat{e}_t$

$N = 25.5\ N$

Check.