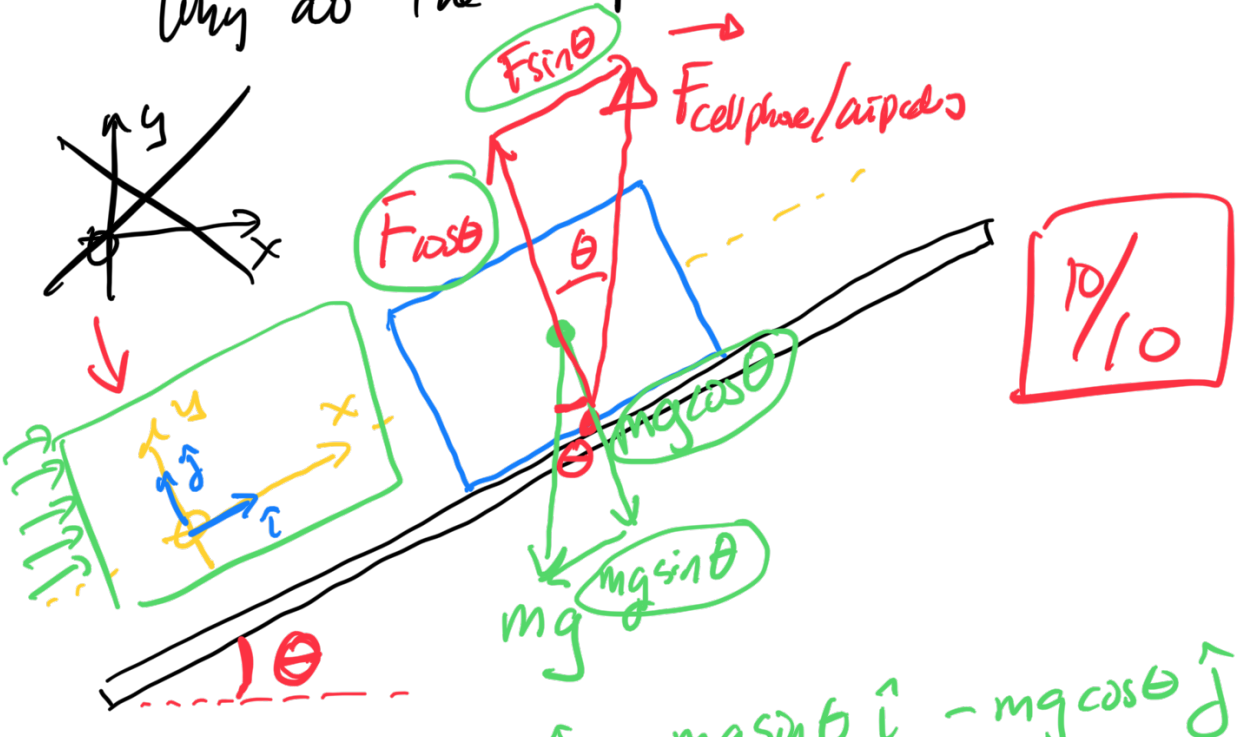
Physics 201 - Lecture 13

→ Assignment 4 (Forces)
Due next Friday, March 5th

→ Today: more about forces!
work through A4 problem

Why do the airpods not move?



$-mg$

① Forces ② coord. sys. ③ break down

Step 1: Free Body Diagram!

→ identify all of the forces

→ choose a coordinate system.

① gravity

② contact forces.

vector

$$\vec{F}_{\text{cellphone/airpods}} ?$$

$$\vec{F}_{net} = \vec{F}_1 + \vec{F}_2 + \dots$$

$$= m\vec{a}$$

$$-mg\hat{j} + \vec{F}_{\text{cellphone/airpods}} = 0 \quad \text{(not moving)}$$

$\vec{F}_{\text{cell phone/carpals}} = +mg\,\hat{j}$

Coordinate system → think about the expected motion

$\vec{a} = a_x\,\hat{i} + \boxed{a_y}\,\hat{j}$

$a_y = 0$!!

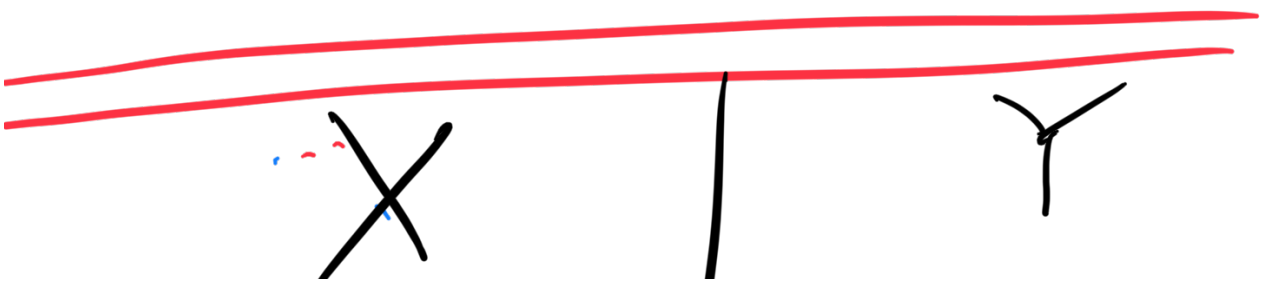
$\vec{F}_{NET} = \overbrace{F^x_{net}}^{\text{all motion}}\,\hat{i} + \boxed{F^y_{net}}\,\hat{j}$

$= 0$!!

$= m\vec{a}$

$= ma_x\,\hat{i} + \overbrace{ma_y}\,\hat{j}$

$= 0$



$\Sigma F_x = ma_x$

$F\sin\theta - mg\sin\theta = 0$ (in this problem)

diagram

$F\sin\theta = mg\sin\theta$

$F = mg$

$\Sigma F_y = ma_y$

$F\cos\theta - mg\cos\theta = 0$ (always)

diagram.

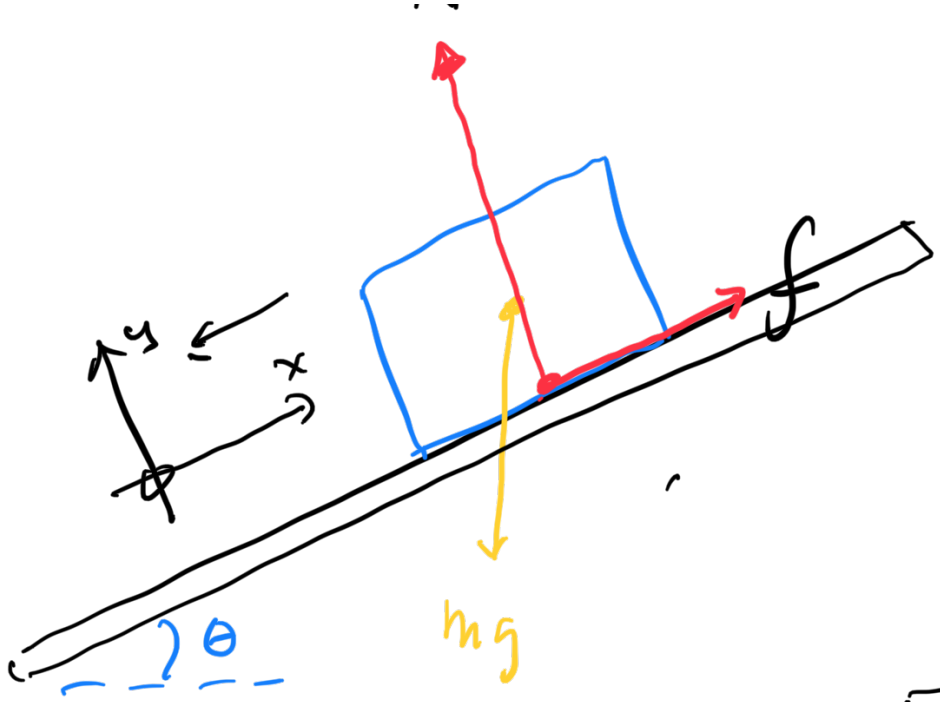
$F\cos\theta = mg\cos\theta$

$F = mg$

$|F| \rightarrow |F_{\text{cell phone/airpods}}| = mg$

WHY? why did it start moving at some angle?

N



Friction !!

$$\vec{F}_{\text{cellphone/airpods}} = \vec{F}_{\perp} + \vec{F}_{\parallel}$$

contact

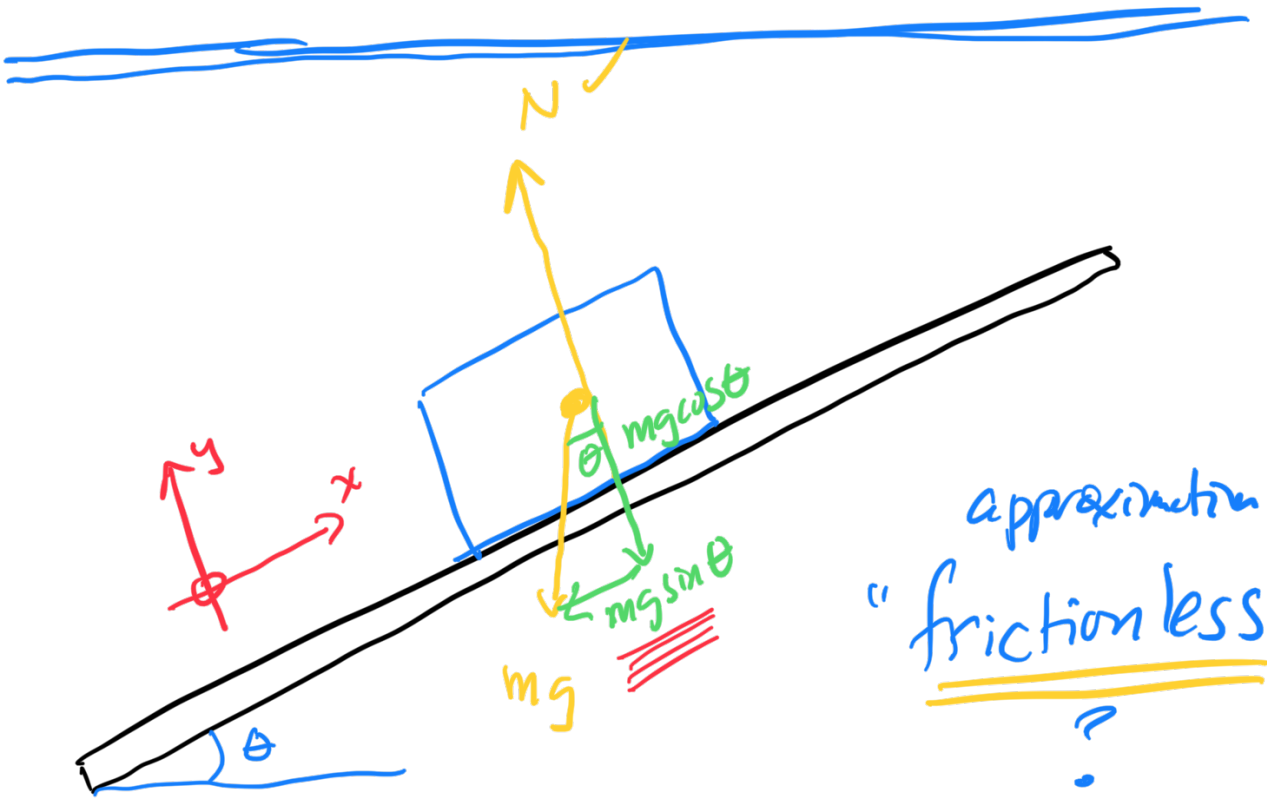
"Normal Force."

$$\vec{F}_{\text{contact}} = \vec{N} + \vec{f}$$

$(\perp)$ $(\parallel)$

THINK about "opposes the motion"

motion.



approximation.

"frictionless"

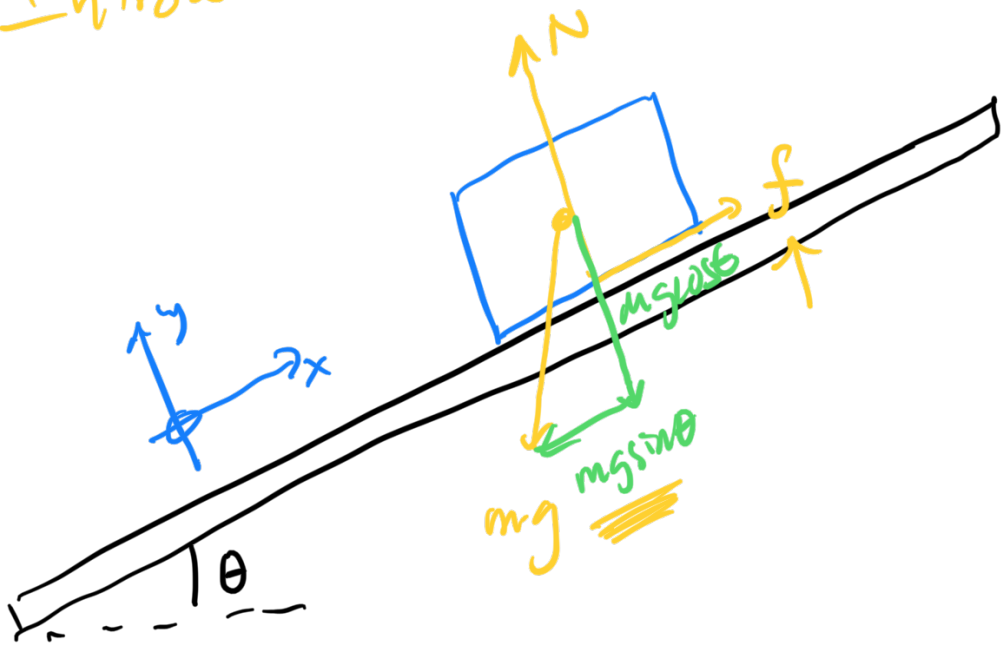
?

X	Y
$\Sigma F_x = ma_x$	$\Sigma F_y = ma_y$
$-mg\sin\theta = ma_x$	$N - mg\cos\theta = 0$
$a = -g\sin\theta$	$N = mg\cos\theta$
	???

$a_x = -g$

☺ ∴ I know the acceleration !!

Introduce friction !



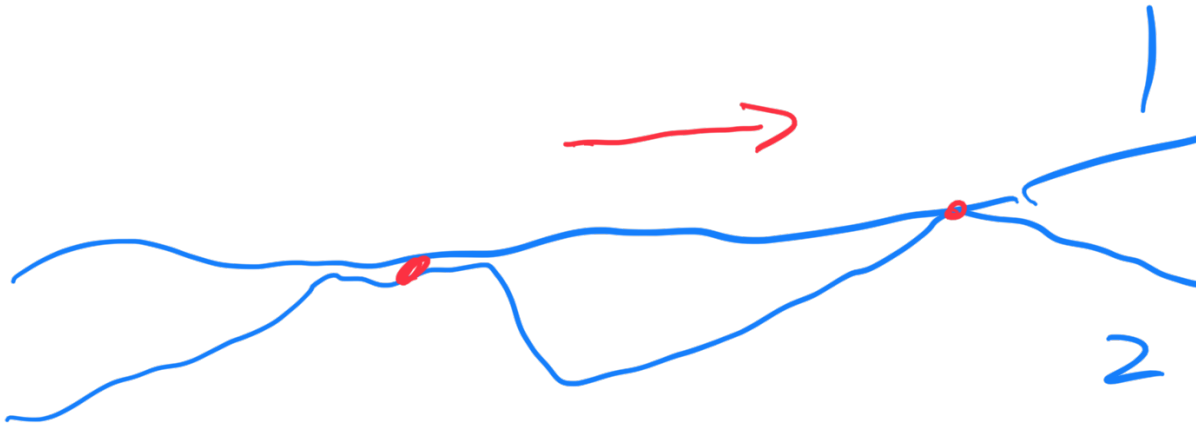
X	Y
$\Sigma F_x = ma_x$	$\Sigma F_y = ma_y = 0$
$-mg\sin\theta + f = ma_x$	$N - mg\cos\theta = 0$

don't know f

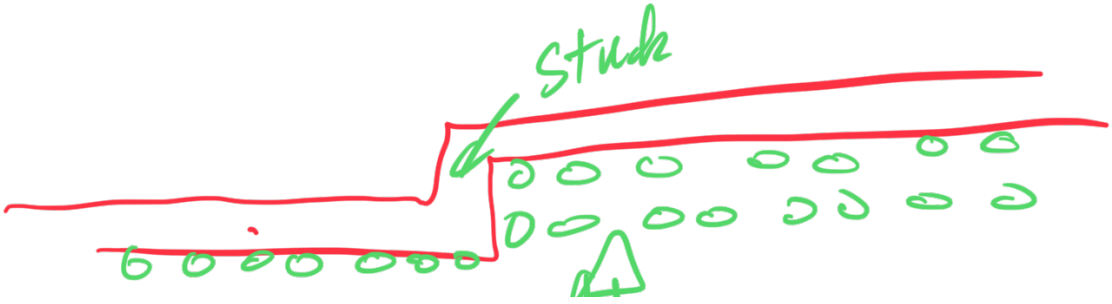
don't know a_x

$N = mg\cos\theta$

Physics of friction



- roughness
- atoms) dislocation.



Summarize

μ (experiment) $\equiv$ coefficient of friction.

small μ $\rightarrow$ little friction (smooth, slippery)

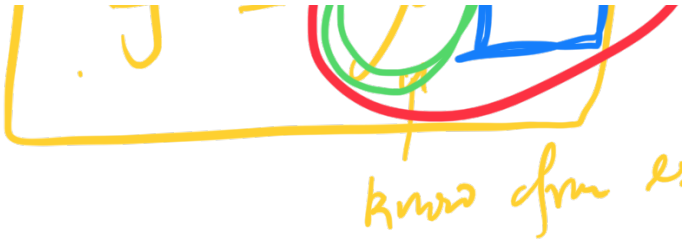
large μ $\rightarrow$ lots of friction (rough

$\mu = 0$ $\rightarrow$ no friction!

$$\mu \equiv \frac{f}{N}$$

definition of friction.

$f = \mu N$



know from expert.

$$-mg\sin\theta + f = ma_x$$

$$-mg\sin\theta + \mu N = ma_x$$

$N = mg\cos\theta$

$$-mg\sin\theta + \mu mg\cos\theta = ma_x$$

$$a_x = -g\sin\theta + \mu g\cos\theta$$

more investigation