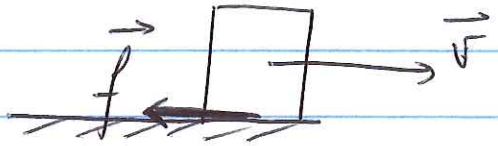
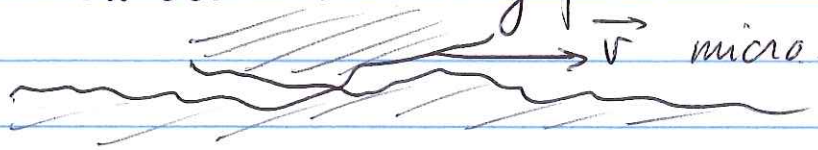
PHYS 107 - Week 4 - Friday

* Friction = resistance against motion, against the direction of motion



How does this sliding friction resist motion?



micro bumps, or even chemical bonds

Is friction useful? Q Friction

No: - wear & tear
- inefficiencies in mechanical systems:
e.g. 20% of car's fuel goes to overcoming friction

Yes: - allows you to walk
- keeps nails in the wall

Study of friction = tribology
originated with da Vinci in 1600
1) independent of contact area
2) independent of relative velocity
3) proportional to normal force

It is different for moving and stationary objects.

→ larger force needed to overcome initial friction

* Kinetic friction: $f_k = \mu_k N$

μ_k: coefficient of kinetic friction
- property of surfaces
- has no units

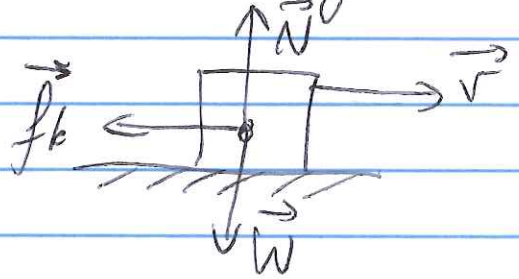
* Static friction: $0 \leq f_s \leq \mu_s N$

μ_s: coefficient of static friction

f_s is as large as needed to keep object from moving
(similar to normal force which is as large as needed to have $a_y = 0$)

* Example of kinetic friction:

Box is sliding on a surface: what is $\vec{a}$?



$N - W = N - mg = 0$

$\hookrightarrow N = mg$

$\hookrightarrow f_k = \mu_k mg$

$$\rightarrow ma = -f_k \rightarrow a = -\frac{f_k}{m} = -\mu_k g$$

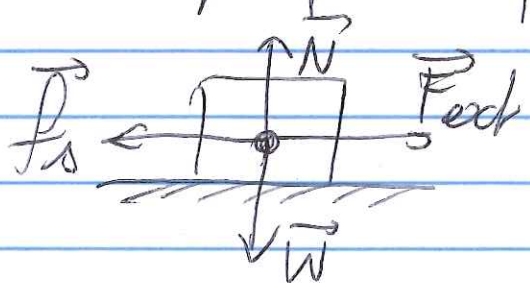
* Connection between μ_k and μ_s

μ_s = chemical bonds exist and energy is needed to break them

μ_k = bonds are already broken

$\hookrightarrow \mu_s \geq \mu_k$

* Example of static friction



$N - W = 0$
$\hookrightarrow N = mg$

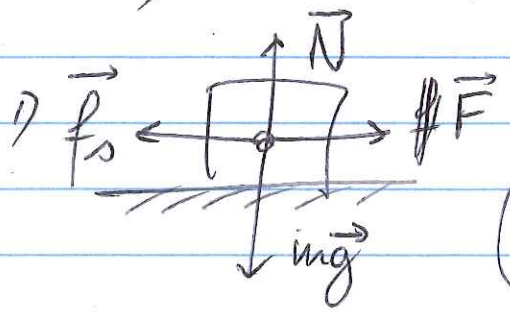
if $F_{ext} = 0 \rightarrow f_s = 0 \rightarrow$ object remains stationary

if $F_{ext} > 0 \rightarrow f_s = F_{ext}$ such that object remains stationary
as long as $f_s \leq \mu_s N = \mu_s mg$

if $F_{ext} > \mu_s mg \rightarrow$ object will start to move

* Example: a block of wood rests on a wooden floor with $\mu_s = 0.5$ and $\mu_k = 0.3$.
$m_{wood} = 1\ kg$
I push with a force of 10N.

1) will the block move?
2) Yes; what is the acceleration?
No; how much harder should I push?

1) 

$\begin{cases} x: N - W = 0 \\ y: F - f_s = 0 \end{cases}$ ← remains static

$\rightarrow N = mg = 10N$

$\hookrightarrow f_s \leq \mu_s N = 5N$

since $F > f_s \rightarrow$ yes, the block will move

2) $F - f_k = ma_x$

$F - \mu_k N = ma_x \rightarrow ma_x = 10N - 3N = 7N$

$\underline{a_x = 7\ m/s^2}$