Lecture 8

17 Ekim 2019 Perşembe 09:42

→ Newton's Laws Motion

1.) Inertia

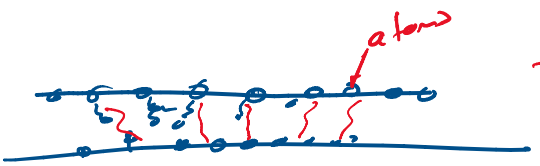
2.) $\vec{F} = m\vec{a}$

3.) Every action has a reaction in equal magnitude and opposite direction

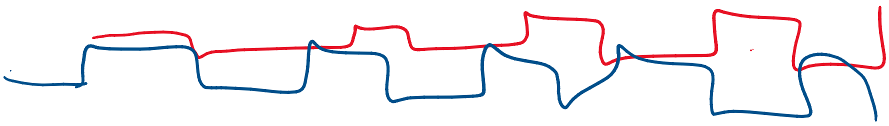
- Dynamics -

> Friction

→ "Force" that opposes the motion



This is an active research area

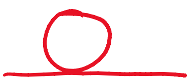


1.) Kinetic friction μ_K

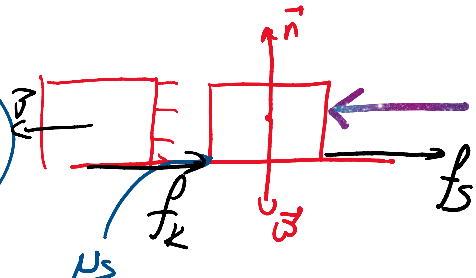
2.) Static friction μ_S

$\mu_K < \mu_S$ → Coefficients of friction

3.) Rolling Friction →



$$f_K = \mu_K \cdot n$$

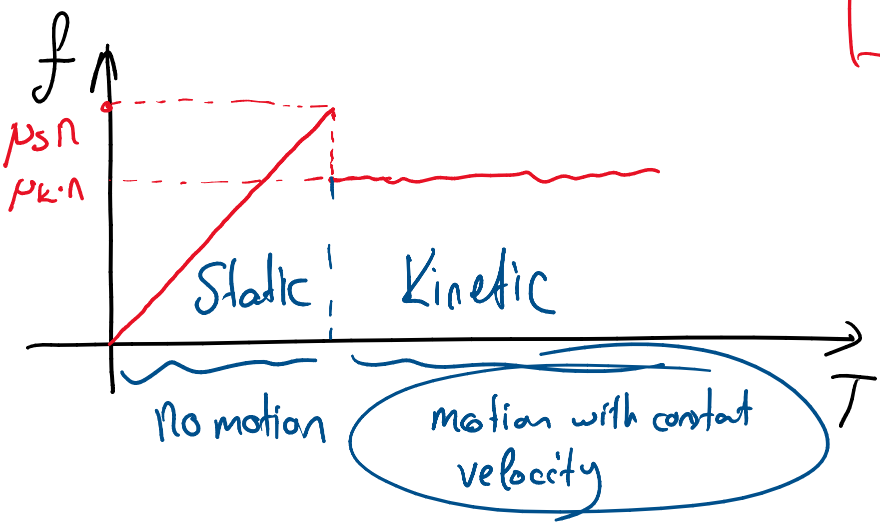


$f \quad .. \quad |\vec{n}|$

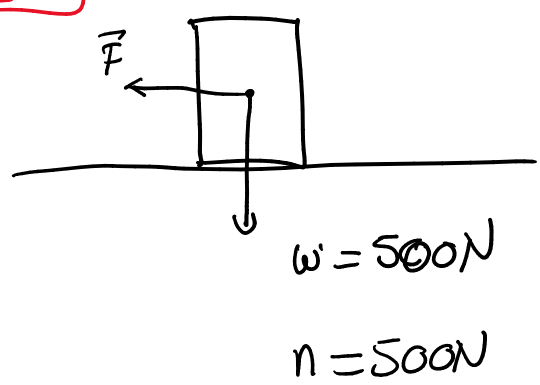
$$f_s = \mu_s \cdot |\vec{n}|$$

$$f_{s\,max} = \mu_s n$$

$$f_s \leq \mu_s n$$



Ex)



$|\vec{F}| = 230N$ inital motion

↓

$|\vec{F}| = 200N$ once it is in motion

μ_s , μ_k

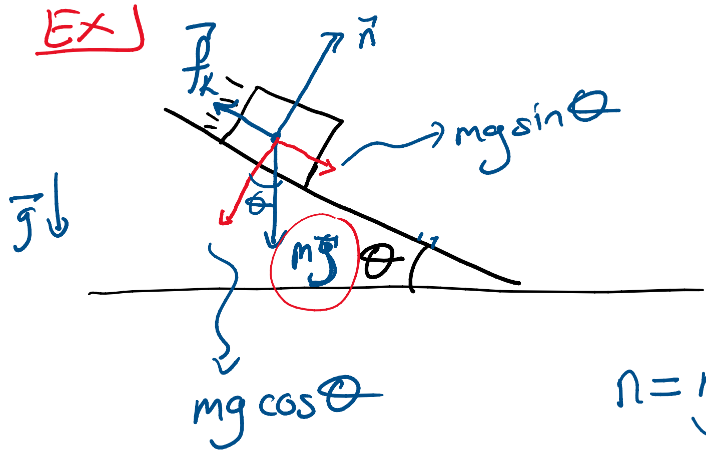
$\mu_s \cdot 500N = 230N$

$\mu_s = 0.46$

$\mu_k \cdot 500N = 200N$

$\mu_k = 0.4$

Ex)



Find μ_k , θ for constant velocity motion

$$\sum \vec{F} = 0 = m\vec{a}$$

$$n = mg\cos\theta$$

$$f_k = mg\sin\theta = \mu_k\, mg\cos\theta$$

$$f_k = mg\sin\theta = \mu_k mg\cos\theta$$

$\mu_k \cdot n$

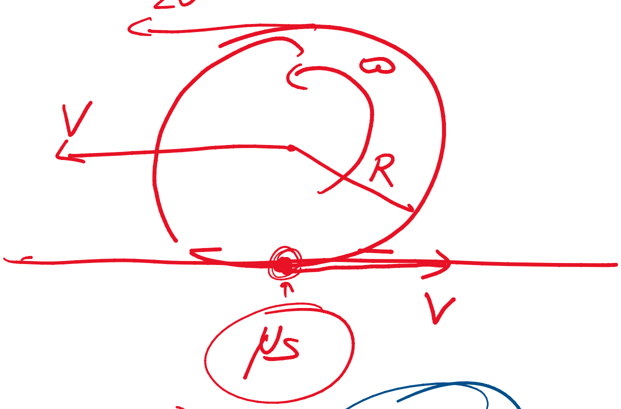
$$\mu_k = \tan\theta$$

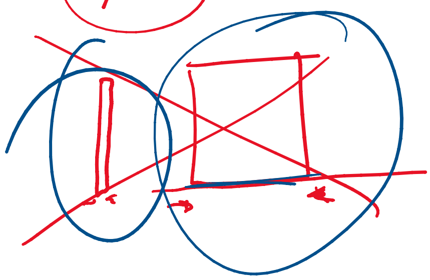
$$\tan^{-1}\mu_k = \theta$$

no mass → $\arctan\mu_k = \theta$

Rolling frictions (μ_r)

↳ friction required to overcome for a wheel to turn on a surface





Fluid Resistance

↳ Air
↳ Liquids

} velocity dependent

$$f = kv$$

f → magnitude of the force

v → velocity

k → shape, size, viscosity of the fluid

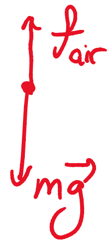
"Low" speeds

$$f = D v^2$$

"High" speed

Not-so 'free' fall

$\vec{g} \downarrow$



$$mg - \underset{kv}{f_{air}} = m.a$$

$$mg - kv = m.\frac{dv}{dt}$$

$$g - \frac{k}{m}v = \frac{dv}{dt}$$

$$dt = \frac{dv}{g - \frac{k}{m}v}$$

$$\int_0^t -\frac{k}{m}dt = \int_0^v \frac{dv}{v - \frac{mg}{k}}$$

$$-\frac{k}{m}.t = \ln\left(v - \frac{mg}{k}\right) - \ln\left(-\frac{mg}{k}\right)$$

$$-\frac{k}{m}t = \ln\left(\frac{v - \frac{mg}{k}}{-\frac{mg}{k}}\right)$$

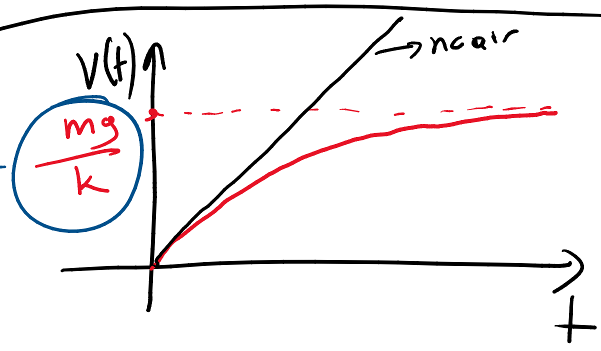
$$e^{-\frac{k}{m}t} = \frac{v - \frac{mg}{k}}{-\frac{mg}{k}} \Rightarrow -\frac{mg}{k}e^{-\frac{k}{m}t} = v - \frac{mg}{k}$$

$$v(t) = \frac{mg}{k}\left(1 - e^{-k/m\, t}\right)$$

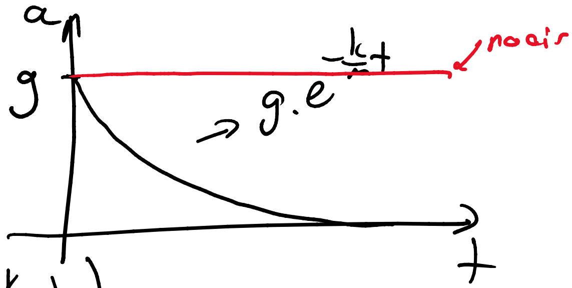
$$v(t) = \frac{mg}{k}\left(1 - e^{\ldots}\right) \quad (\to 0)$$

$$\downarrow$$

$$a(t) = \frac{dv}{dt} = g \cdot e^{-\frac{k}{m}t}$$



Terminal velocity



$$y(t) = v_t\left(t - \frac{m}{k}\left(1 - e^{-\frac{k}{m}t}\right)\right)$$

Dynamics of Circular Motion

Chapter 5.3