Last Time

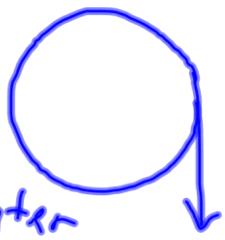
3 Kinematics equation

- xt: $x = \frac{1}{2}at^2$
- vt: $v = at$
- vx: $v = \sqrt{2ax}$

where $x_0 = 0$, $v_0 = 0$

Uniform Circular Motion

$$a = \frac{v^2}{r}$$



$\vec{a}$ points to center

$\vec{v}$ $|\vec{v}| = v = \text{constant}$

constant

$\vec{a}$ is called the "centripetal acceleration"

$\vec{v}$ is not constant

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(1) Review Kinematics

- Horizontal and verticle problems separate
- How to choose equation to use
  xt, vt, or vx ?

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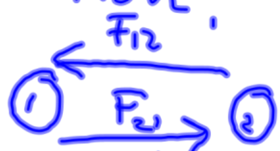
② Newton's Laws

1. Object in motion remains in motion, object at rest remains at rest, if no forces act on object.

2. Force = mass X acceleration

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

3. For every action there is an equal and opposite reaction.



$$\vec{F}_{12} = -\vec{F}_{21} \qquad F_{12} = F_{21}$$

$\vec{F}_{12}$ = Force on object #2 due to object #1
F_{21} = " " " #1 " " " #2

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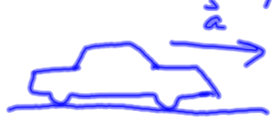
example a car of mass 2000 kg is accelerated at the rate of $10\, m/s^2$. What is the force acting on the car?



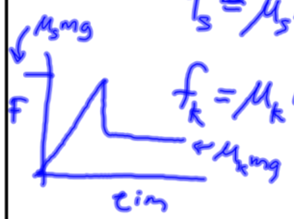
$F = ma$

$= (2000\, kg)(10\, m/s^2) = 20{,}000\ \frac{kg\, m}{s^2}$

$= 20{,}000\ N$

③ Forces

A. Friction (contact forces)



$f_s \le \mu_s mg$ μ_s = coefficient of static friction

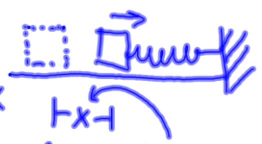
$f_k = \mu_k mg$ μ_k = coefficient of kinetic friction

$f_r = \mu_r mg$ μ_r = coefficient of rolling friction

$\mu_s > \mu_k > \mu_r$

B. Elastic Forces

$F_{spring} = -kx$



spring constant

displacement from equilibrium

equilibrium position

C. Fundamental Forces

1. Gravity
2. Electromagnetism
3. Weak force
4. Strong

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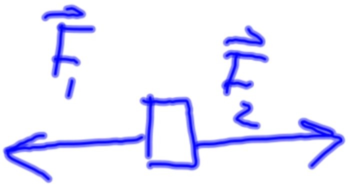
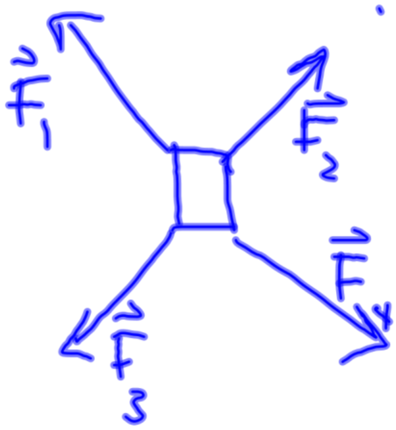
④ Equilibrium

all forces on a object add up to zero.



1D Equilibrium

$$\vec{F}_1 + \vec{F}_2 = 0$$



2D Equilibrium

$$\vec{F}_1 + \vec{F}_2 + \vec{F}_3 + \vec{F}_4 = 0$$

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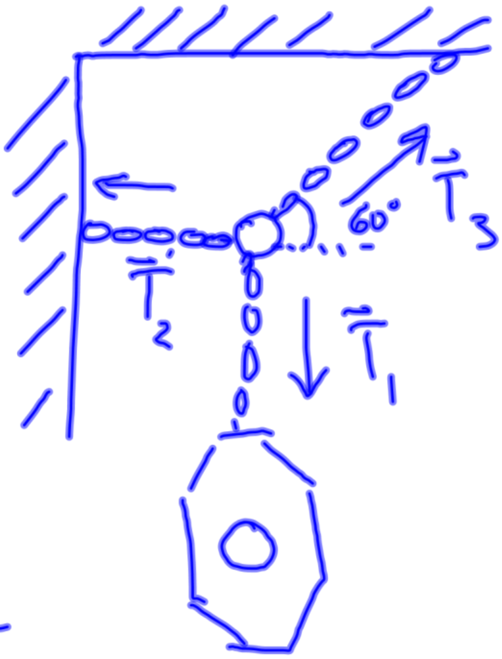

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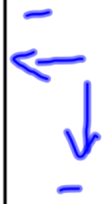
$$\vec{T}_1 + \vec{T}_2 + \vec{T}_3 = 0$$

horizontal equation

$$0 - T_2 + T_3\cos(60) = 0$$

$$-T_2 + \frac{1}{2}T_3 = 0$$



verticle equation

$$-T_1 + 0 + T_3\sin(60°) = 0$$

$$-T_1 + \frac{\sqrt{3}}{2}T_3 = 0$$

$$T_1 = W$$

$$T_3 = \frac{2}{\sqrt{3}}W$$

$$T_2 = \frac{1}{\sqrt{3}}W$$

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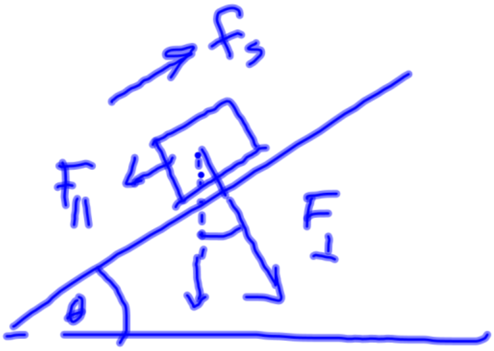
(5) mass on an inclined plane

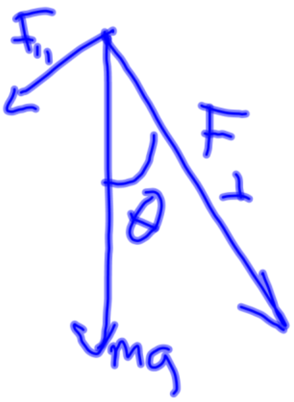


$$f_s \leq \mu_s F_{\perp}$$

$$F_{\perp} = mg\cos\theta$$

what must θ be for mass to slide?

$$f_s < \mu_s mg\cos\theta \qquad F_{\parallel} = mg\sin\theta$$



$$mg\sin\theta > \mu_s mg\cos\theta$$

$$\frac{\sin\theta}{\cos\theta} > \mu_s$$

$$\tan\theta > \mu_s$$

$$\theta > \arctan(\mu_s)$$

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