Warum Theorie A?

- <u>Kultur</u> der theoretischen Physik
- <u>Sprache</u> —— " ——

  Mathematik

- Schönheit der Welt besser zu verstehen!

Wie überlebe ich Theorie A?

- <u>Vorlesung</u>!
- <u>Übungen</u>!
- Vertraue niemals dem Vorlesenden!

Newtonschen Gesetze

1. auf einen Körper wirkt keine Kraft.

→ Wenn d. Körper in Ruhe ist, dann bleibt er in Ruhe

→ Wenn sich d. Körper mit const. Geschwindigkeit bewegt, dann bleibt $\vec{v}$ unverändert!

$$\vec{v} = \begin{pmatrix} v_x \\ v_y \\ v_z \end{pmatrix}$$

$$\boxed{\frac{d\vec{v}}{dt} = 0}$$

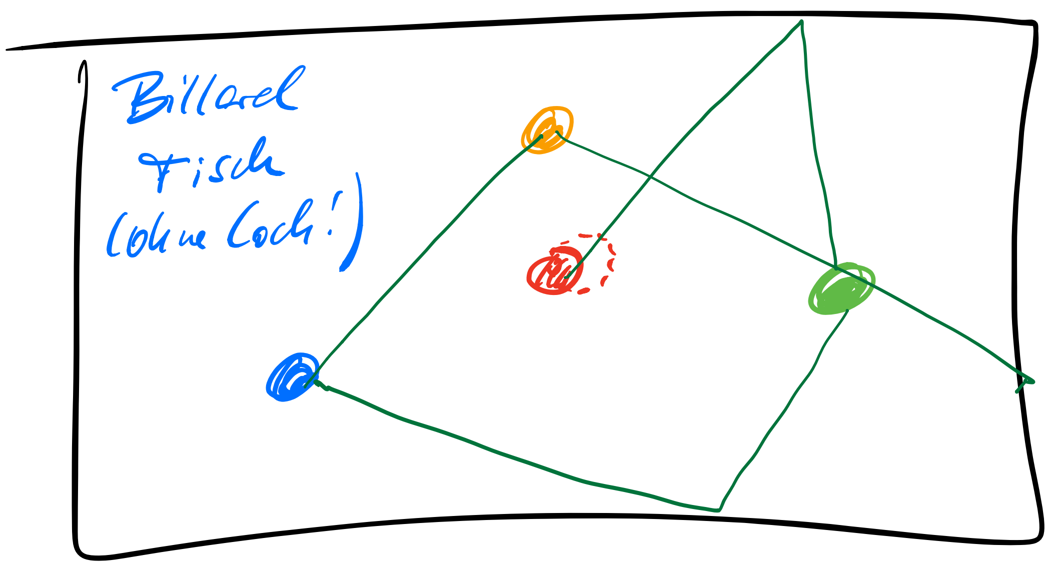
Massepunkt:

$$\vec{r}(t) = \begin{pmatrix} x(t) \\ y(t) \\ z(t) \end{pmatrix} = \begin{pmatrix} x_1(t) \\ x_2(t) \\ x_3(t) \end{pmatrix}$$

Zur Erinnerung:

$$\frac{df(t)}{dt} = \lim_{\Delta \to 0} \frac{f(t+\Delta) - f(t)}{\Delta}$$

$$\frac{d\vec{v}}{dt} = \begin{pmatrix} \frac{dv_x}{dt} \\ \frac{dv_y}{dt} \\ \frac{dv_z}{dt} \end{pmatrix}$$



$$\frac{d\vec{v}}{dt} = \vec{0}$$

$$\frac{dv_x}{dt} = 0$$

$$\vec{0} = \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}$$

$$\frac{dv_y}{dt} = 0$$

$$\frac{dv_z}{dt} = 0$$

<u>Lösung</u>:

$$\vec{v}(t) = \vec{v}_0 = \text{const.}$$

Wenn das 1. Newton'sche Gesetz gilt, dann handelt es sich um ein Inertialsystem!

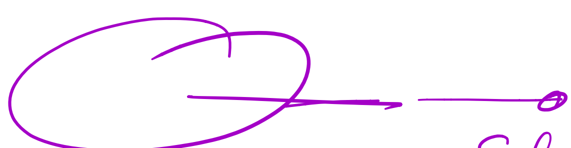
2. Gesetz

$$\boxed{\frac{d\vec{v}(t)}{dt} \sim \vec{F}}$$

$$\cancel{\sim \vec{F}\,(\vec{F}\cdot\vec{F})}$$

$$\boxed{\frac{d\vec{v}}{dt} = \frac{1}{m}\vec{F}}$$

träge Masse

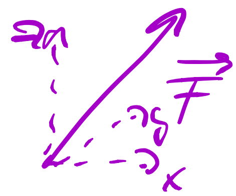


Schwere Masse

$$\boxed{m \frac{d^2 \vec{r}}{dt^2} = \vec{F}}$$

Konstantes Kraftfeld

$$\vec{F} = \begin{pmatrix} F_0 \\ 0 \\ 0 \end{pmatrix}$$



$$\vec{F} = \begin{pmatrix} 0 \\ 0 \\ F_0 \end{pmatrix}$$

3-Gleichungen

$$m \frac{d^2 x}{dt^2} = F_0$$

$$m \frac{d^2 y}{dt^2} = 0$$

$$m \frac{d^2 z}{dt^2} = 0$$

Notation:

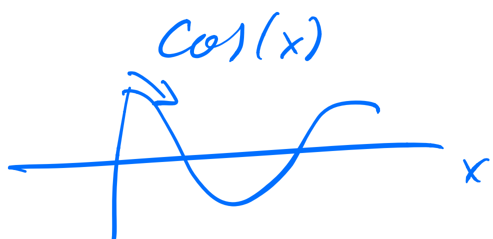
$$\frac{d^2 f}{dt^2} = \frac{d}{dt}\left(\frac{df}{dt}\right)$$

Ableitungen:

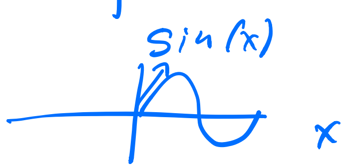
$$f'(x) = \lim_{\Delta \to 0} \frac{f(x+\Delta) - f(x)}{\Delta}$$

$f(x) = \sin(x)$ $\qquad$ $f'(x) = \cos(x)$

$$f''(x) = \lim_{\Delta \to 0} \frac{f'(x+\Delta) - f'(x)}{\Delta}$$



$f''(x) = -\sin(x)$



$$f'(t) \equiv \frac{d f(t)}{dt}$$

$$f''(t) = \frac{d^2 f(t)}{dt^2} \quad \dots \quad f^{(6)}(t) = \frac{d^6 f(t)}{dt^6}$$

3-Gleichungen

$$m \frac{d^2x}{dt^2} = F_0$$

$$m \frac{d^2y}{dt^2} = 0$$

$$m \frac{d^2z}{dt^2} = 0$$

$$\boxed{v_y(t) = v_y^{(0)}}$$

$$v_z(t) = v_z^{(0)}$$

$$\frac{dy}{dt} = v_y^{(0)}$$

$$\frac{dz}{dt} = v_z^{(0)}$$

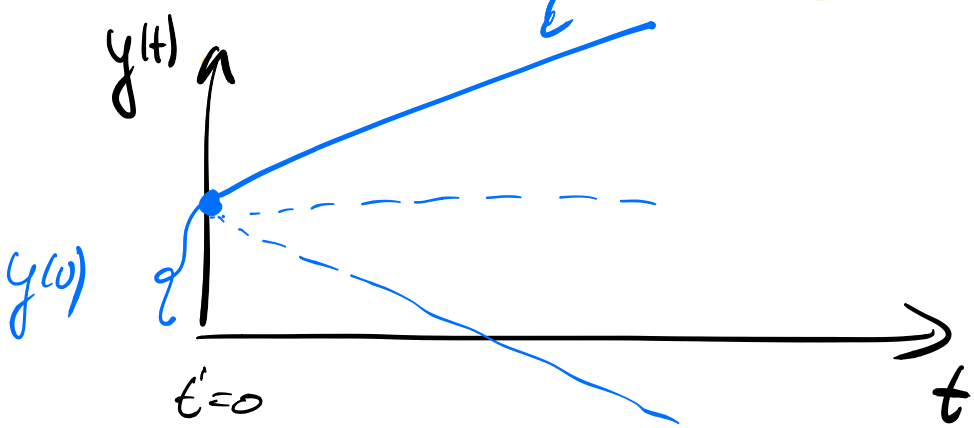
$$\int_0^t dt' \frac{dy}{dt'} = \int_0^t v_y^{(0)} \, dt'$$

$$\int_0^t dt' = t$$

$$\int_a^b \frac{df}{dx}\,dx = f(b) - f(a)$$

$$y(t) - y(0) = v_y^{(0)}\, t$$

$$y(t) = y(0) + \boxed{v_y^{(0)}}\, t$$



3-Gleichungen

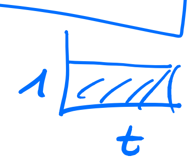
$$m\frac{d^2x}{dt^2} = F_0$$

$$m\frac{dy^2}{dt^2} = 0$$

$$m\frac{dz^2}{dt^2} = 0$$

$$y(t) = y(0) + v_y^{(0)} t$$

$$z(t) = z(0) + v_z^{(0)} t$$



$$\int_0^t dt' \frac{dv_x}{dt'} = \int_0^t F_0/m \, dt' = \frac{F_0}{m}\int_0^t dt'$$

$$v_x(t) - v_x^{(0)} = \frac{F_0}{m} t$$

$$\boxed{v_x(t) = v_x^{(0)} + \frac{F_0}{m} t}$$

$$\frac{dx}{dt} = v_x^{(0)} + \frac{F_0}{m} t$$

$$\frac{d^2x}{dt^2} = F_0/m \qquad v_x(t) = \frac{dx}{dt}$$

$$\frac{dv_x(t)}{dt} = F_0/m$$

L. $\displaystyle\int_0^t \frac{dv_x(\hat{t})}{d\hat{t}}\, d\hat{t} = \underline{v_x(t)} - v_x(0)$

$v_x(0) = v_x^{(0)}$

R: $\displaystyle\int_0^t F_0/m \, dt' = \frac{F_0}{m} t$

$$\boxed{v_x(t) = v_x^{(0)} + \frac{F_0}{m} t}$$

$$\frac{dx}{dt} = v_x^{(0)} + \frac{F_0}{m} t$$

$$\int_0^t \frac{dx(t')}{dt'} dt' = \int_0^t \left(v_x^{(0)} + \frac{F_0}{m} t' \right) dt'$$

$$x(t) - \underbrace{x(0)}_{= x^{(0)}} = v_x^{(0)} t + \frac{F_0}{2m} t^2$$

$$x(t) = x^{(0)} + v_x^{(0)} t + \frac{F_0}{2m} t^2$$

kombinieren wir das in eine Vektorgleichung!

$$\boxed{\vec{r}(t) = \vec{r}^{(0)} + \vec{v}^{(0)} t + \frac{1}{2m} \vec{F}_0 t^2}$$