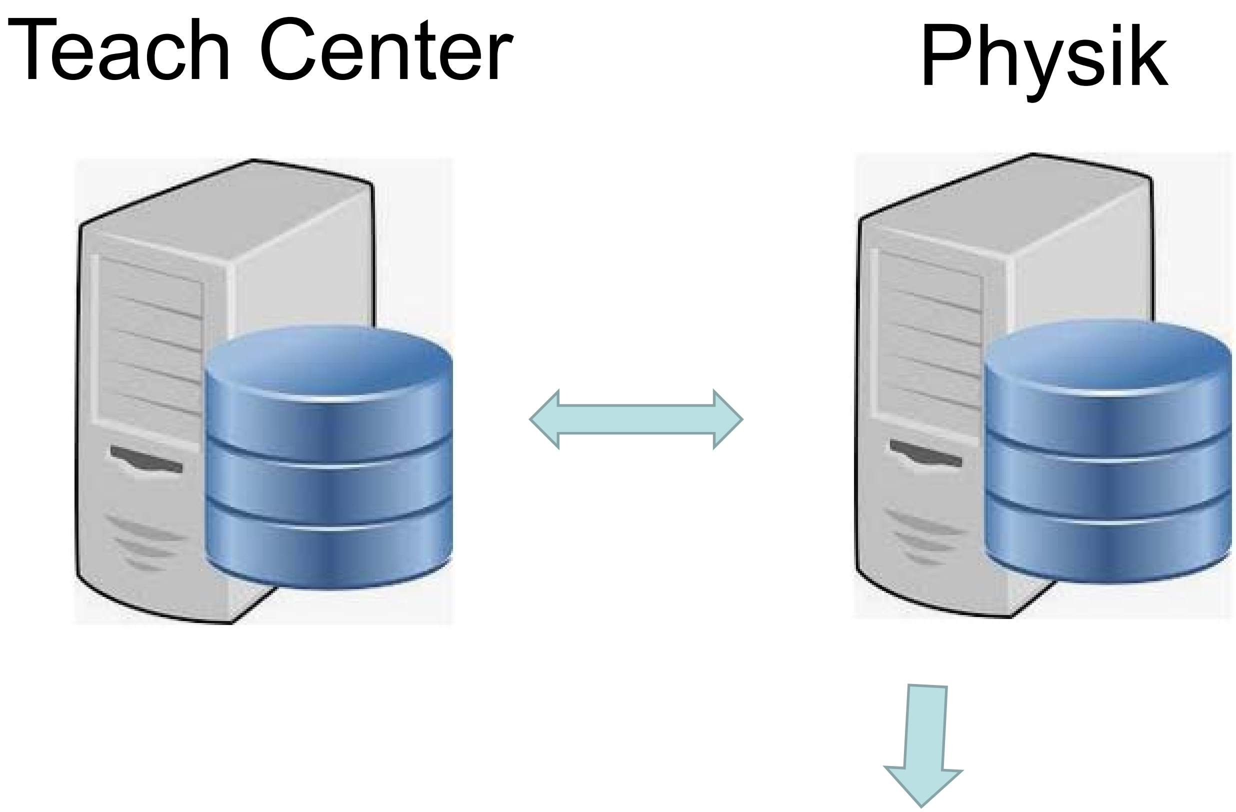
5. Punktmechanik

18 Okt. 2019



exam_id	number	user_id	params
ball	ball	73957	{"name":"ball","v":19,"m":205,"theta":43,"vx":"13....
G	ball	76103	{"name":"ball","v":12,"m":231,"theta":45,"vx":"8.4...
v2f	ball	76103	{"name":"ball","v":12,"m":231,"theta":45,"vx":"8.4...
G	G	74962	{"name":"G","x1":2,"y1":-3,"z1":-4,"x2":-5,"y2":3,...

Python

```
import math;

# define some constants
e = -1.6022E-19; # electron charge in C
eps = 8.85E-12;  # permitivity in F/m
pi = math.pi;

# position of electron 1 in m
r1x = 1E-9;
r1y = 2E-9;
r1z = 3E-9;

#position of electron 2 in m
r2x = -2E-9;
r2y = 4E-9;
r2z = -1E-9;

# vector pointing from 1 to 2
r12x = r2x -r1x;
r12y = r2y -r1y;
r12z = r2z -r1z;

# length of vector r12
r_len = math.sqrt(r12x*r12x + r12y*r12y + r12z*r12z);
```

Python

```
# vector pointing from 1 to 2
r12x = r2x -r1x;
r12y = r2y -r1y;
r12z = r2z -r1z;

# length of vector r12
r_len = math.sqrt(r12x*r12x + r12y*r12y + r12z*r12z);

# unit vector pointing from 1 to 2
ex = r12x/r_len;
ey = r12y/r_len;
ez = r12z/r_len;

# Force in N
Fx= e*e*ex/(4*pi*eps*r_len*r_len);
Fy= e*e*ey/(4*pi*eps*r_len*r_len);
Fz= e*e*ez/(4*pi*eps*r_len*r_len);

print('Fx = ' + str(Fx) + 'N');
print('Fy = ' + str(Fy) + 'N');
print('Fz = ' + str(Fz) + 'N');
```

Javascript

```
<script>

// define some constants
e = -1.6022E-19; // electron charge in C
eps = 8.85E-12;  // permitivity in F/m
pi = Math.PI;

// position of electron 1 in m
r1x = 1E-9;
r1y = 2E-9;
r1z = 3E-9;

// position of electron 2 in m
r2x = -2E-9;
r2y = 4E-9;
r2z = -1E-9;

// vector pointing from 1 to 2
r12x = r2x -r1x;
r12y = r2y -r1y;
r12z = r2z -r1z;

// length of vector r12
r_len = Math.sqrt(r12x*r12x + r12y*r12y + r12z*r12z);

// unit vector pointing from 1 to 2
ex = r12x/r_len;
```

Punktmechanik

$$\vec{r} \quad \Longleftrightarrow \quad \vec{v} \quad \Longleftrightarrow \quad \vec{a} \quad \Longleftrightarrow \quad \vec{F}$$

Punktmechanik

$$\vec{v} = \frac{d\vec{r}}{dt} \qquad \vec{a} = \frac{d\vec{v}}{dt} \qquad \vec{F} = m\vec{a}$$

$$\vec{r} \qquad \vec{v} \qquad \vec{a} \qquad \vec{F}$$

Punktmechanik

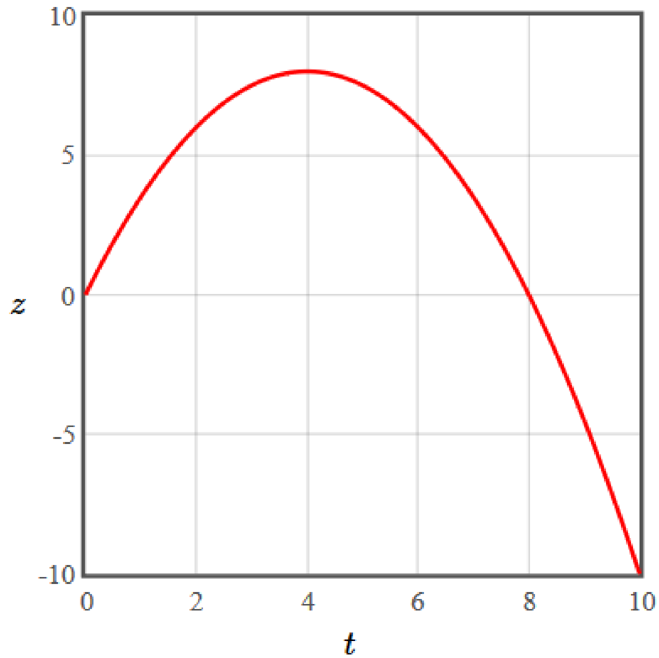
$\vec{r}$ $\vec{v}$ $\vec{a}$ $\vec{F}$

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

$$\vec{r}(t) = \int_{t_0}^{t} \vec{v}(t')dt' + \vec{r}(t_0)$$

$$\vec{v}(t) = \int_{t_0}^{t} \vec{a}(t')dt' + \vec{v}(t_0)$$

Konstante Kraft = Parabelbewegung



$$\vec{r} = \left(x_0 + v_{x0}t + \frac{F_x}{2m}t^2\right)\hat{x} + \left(y_0 + v_{y0}t + \frac{F_y}{2m}t^2\right)\hat{y} + \left(z_0 + v_{z0}t + \frac{F_z}{2m}t^2\right)\hat{z}$$

$$\vec{v} = \left(v_{x0} + \frac{F_x}{m}t\right)\hat{x} + \left(v_{y0} + \frac{F_y}{m}t\right)\hat{y} + \left(v_{z0} + \frac{F_z}{m}t\right)\hat{z}$$

$$\vec{a} = \frac{F_x}{m}\hat{x} + \frac{F_y}{m}\hat{y} + \frac{F_z}{m}\hat{z}$$

$$\vec{F} = F_x\hat{x} + F_y\hat{y} + F_z\hat{z}$$

$z_0 = 0$ m $\quad m = 1$ kg

$F_z =$ -1.00 [N] [-] [+]

$v_{z0} = 4.00$ [N] [-] [+]

restart

Erläuterung: [+] [-]

Fähigkeiten

Mechanik punktartiger Teilchen

Bei gegebener Position $\vec{r}$ [m], Geschwindigkeit $\vec{v}$ [m/s], Beschleunigung $\vec{a}$ [m/s²], oder Kraft $\vec{F}$ [N] als Funktion der Zeit eines Teilchens, müssen Sie in der Lage dazu sein, jede der vier Grössen durch Integrieren oder Ableiten der anderen Grössen zu erhalten.

App: Numerische Integration und Differentiation von Funktionen in Abhängigkeit von t.

Position → Velocity → Acceleration

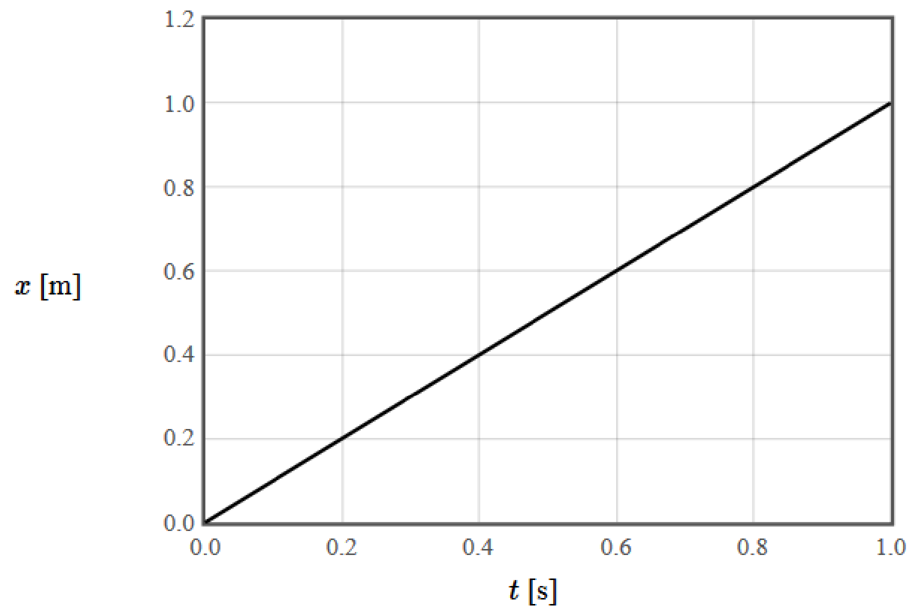
$x(t) =$ t [m] ?

Calculate from formula in the range from $t_1 =$ 0 [s] to $t_2 =$ 1 [s].

Zero force | Constant force | Terminal velocity | Harmonic motion

t [s]	x [m]
0	0
0.001	0.001
0.002	0.002
0.003	0.003
0.004	0.004
0.005	0.005
0.006	0.006
0.007	0.007
0.008	0.008
0.009	0.009
0.01	0.01

calculate from table



Position → Kraft (numerisch)

Ein auf einer geraden Straße fahrendes Auto hat ein GPS-Gerät installiert, welches die Position des Autos speichert. Die Masse des Autos ist 1175 kg. Welche Kraft wirkt auf das Auto zur Zeit t =20 s?

Differenzieren Sie mittels der APP Numerische Integration.

t [s]	x [m]
0.00	7.0000000
0.500	14.191468
1.00	21.556045
1.50	29.073493
2.00	36.721801
2.50	44.477305
3.00	52.314830
3.50	60.207848
4.00	68.128647
4.50	76.048522
5.00	83.937969

solution

Acceleration → Velocity → Position

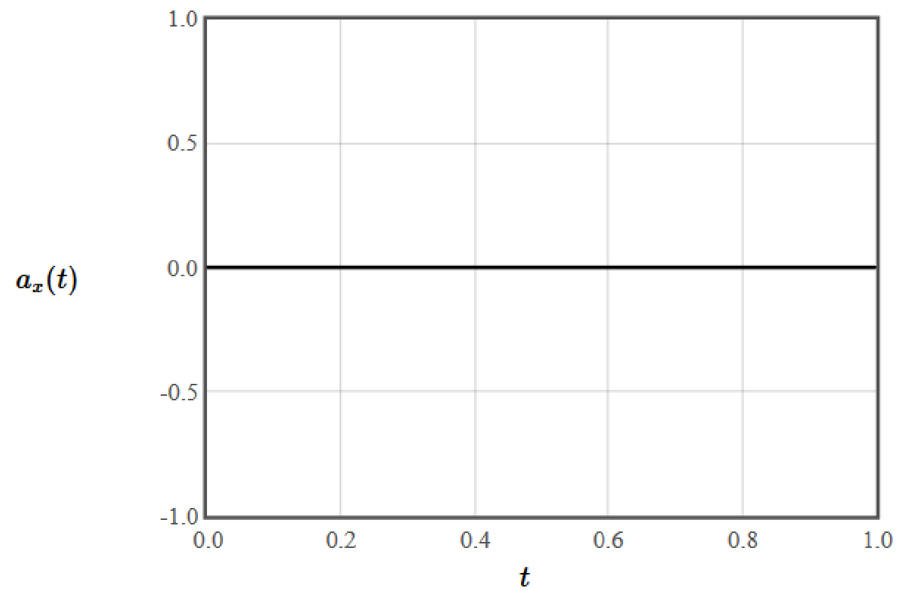
$a(t) =$ 0 [m/s²] ?

Calculate from formula in the range from $t_1 =$ 0 [s] to $t_2 =$ 1 [s].

Zero force | Constant force | Terminal velocity | Harmonic motion

t	$a_x(t)$
0	0
0.001	0
0.002	0
0.003	0
0.004	0
0.005	0
0.006	0
0.007	0
0.008	0
0.009	0
0.01	0

calculate from table



TU Graz

511.015 Physik M en

- Lehrplan
- Bücher
- Testfragen

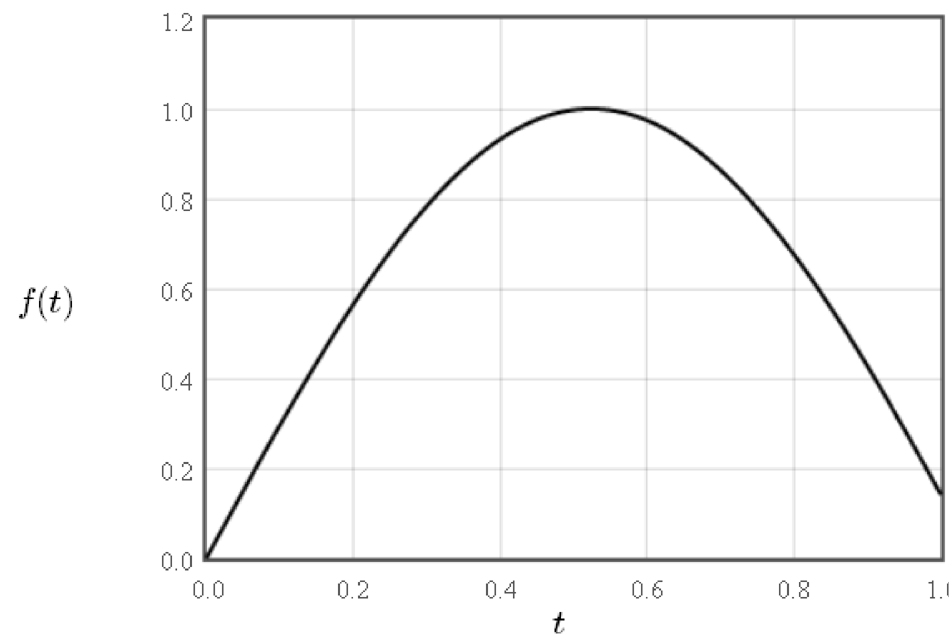
Numerische Integration and Differentiation

$f(t) =$ sin(3*t) ?

Fill table from $t_1 = 0$ to $t_2 = 1$.

t	$f(t)$
0.02000	0.05996
0.02333	0.06994
0.02667	0.07991
0.03000	0.08988
0.03333	0.09983
0.03667	0.1098
0.04000	0.1197
0.04333	0.1296
0.04667	0.1395
0.05000	0.1494
0.05333	0.1593

calculate from table

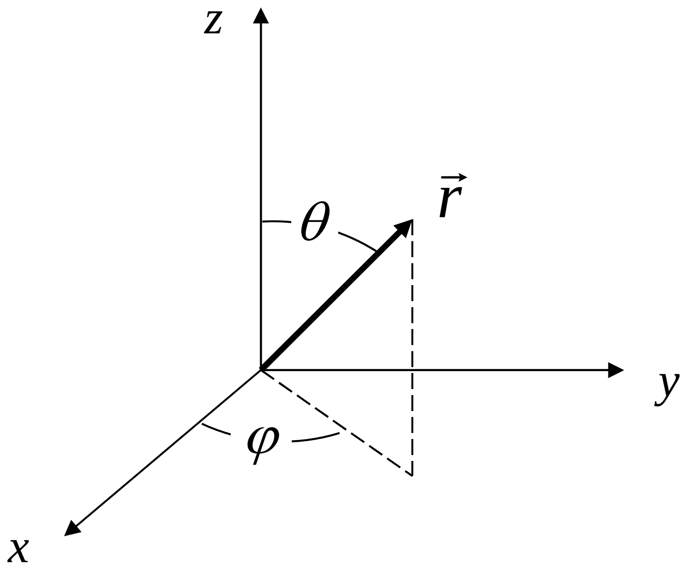


Die 1. Ableitung
Die Ableitung von $f(t)$ wird berechnet aus

$$\frac{df}{dt} \approx \frac{f(t+\Delta t)-f(t)}{\Delta t}.$$

Corioliskraft

$$\vec{r}\left(t\right) = R\sin\left(\Omega t\right)\cos\left(\omega t\right)\hat{x} + R\sin\left(\Omega t\right)\sin\left(\omega t\right)\hat{y} + R\cos\left(\Omega t\right)\hat{z}$$



$$\theta = \Omega t$$

$$\varphi = \omega t$$

$\vec{F}$?

Müssen wir die Coriolis-Kraft für die Prüfung wissen?

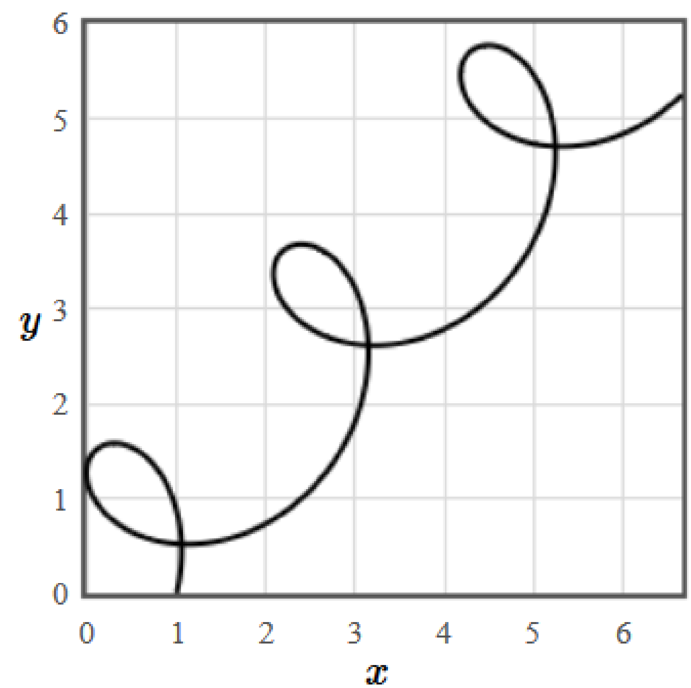
Problem 2

Die Bahnkurve eines Teilchens der Masse $m = 33$ g ist,

$$\vec{r}(t) = \big(t + \cos(3t)\big)\,\hat{x} + \big(t + \sin(3t)\big)\,\hat{y} \quad [\mathrm{m}].$$

immer Radiant

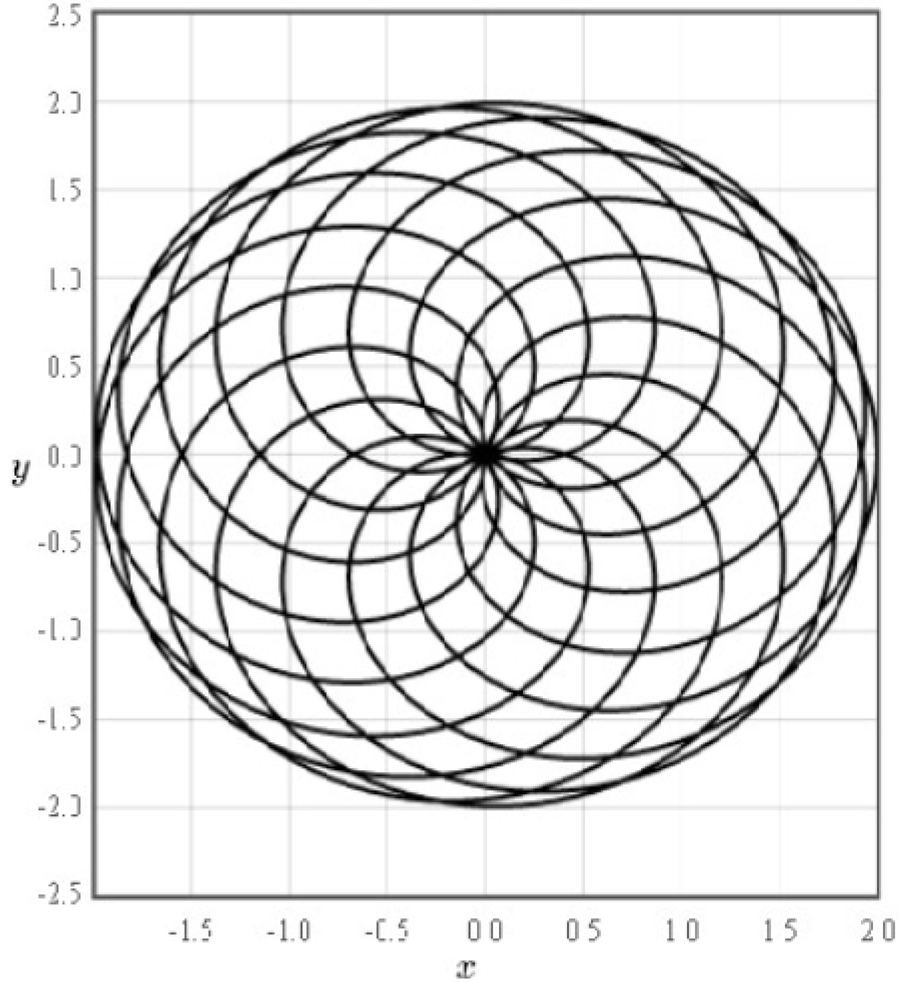
Dabei ist t die Zeit in Sekunden.



Welche Kraft wirkt auf das Teilchen zur Zeit $t = 1$ s?

$$\vec{F} = \boxed{}\,\hat{x} + \boxed{}\,\hat{y} + \boxed{}\,\hat{z}\ [\mathrm{N}]$$

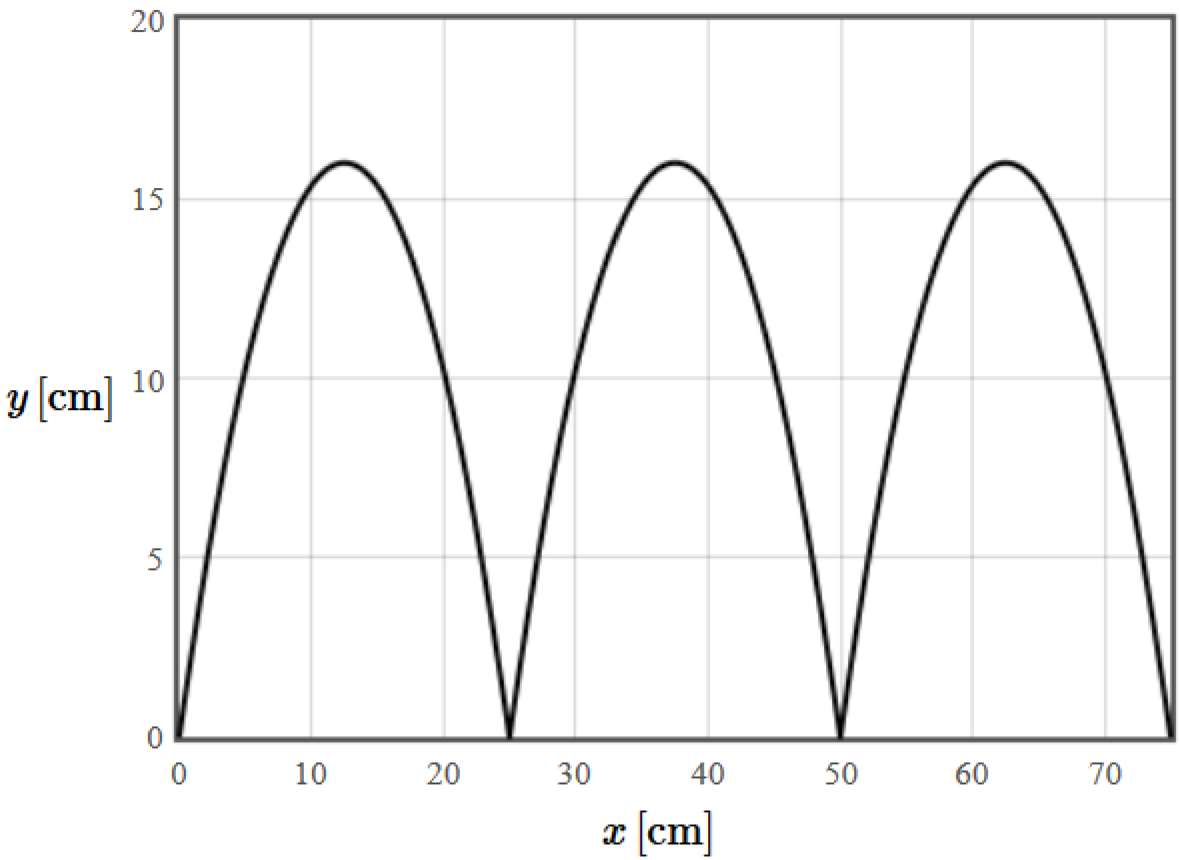
Bahnkurve



$$\vec{r}(t) = (\cos(2\pi t) + \cos(7.2\pi\ \mathrm{t}))\,\hat{\mathrm{x}} + (\sin(2\pi t) + \sin(7.2\pi\ \mathrm{t}))\,\hat{y}$$

immer Radiant

Pruefung 29.06.2017



$$\vec{r} = t\hat{x} + \frac{64}{625}\left(25t - t^2\right)\hat{y} + 0\hat{z} \quad [\text{cm}]$$