Estudo da resistência do ar

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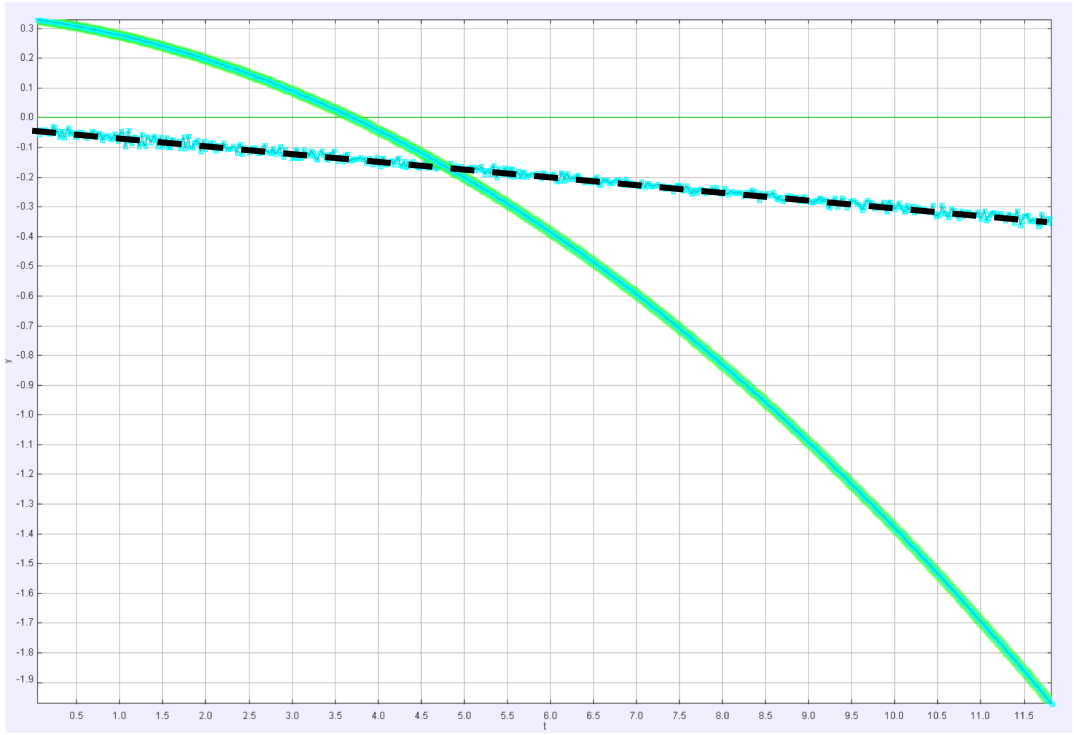
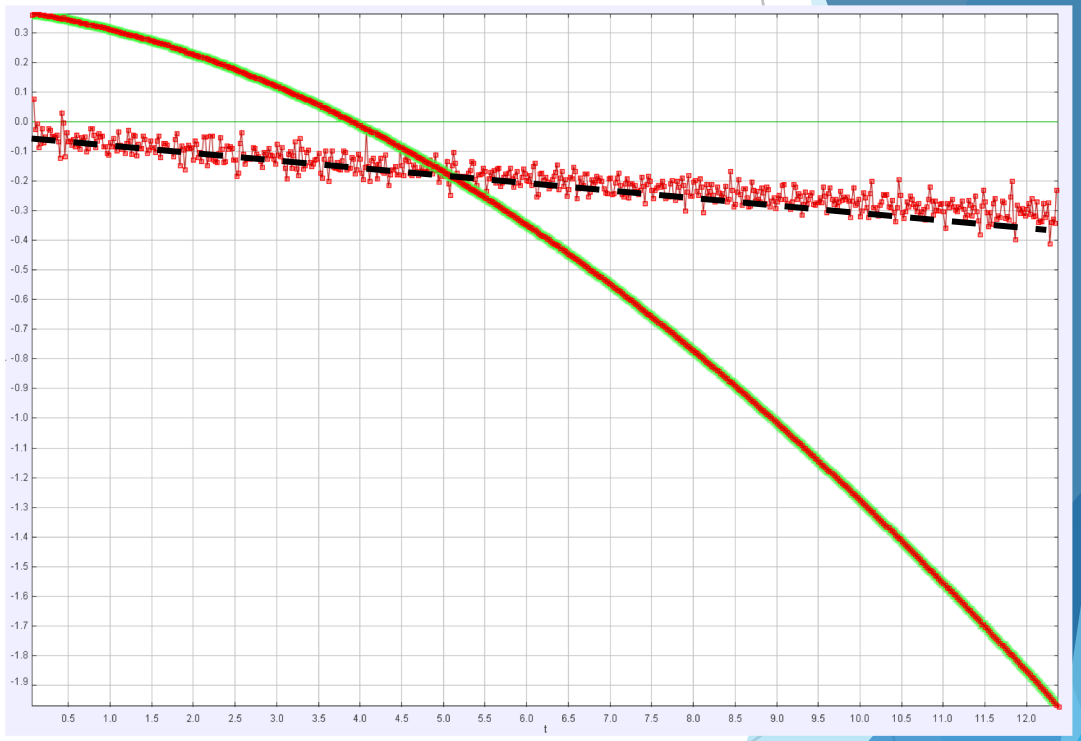
Hipótese: $F \propto v$

$F = -\gamma v$



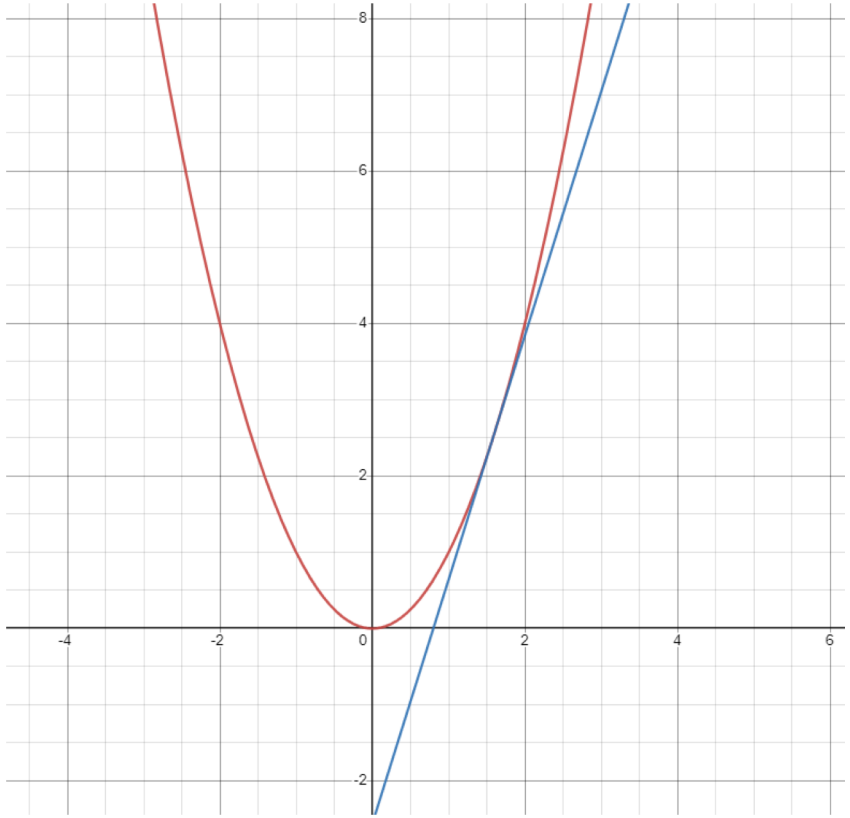
Bola de metal



Bola de ping-pong

Derivadas

- $\frac{dx}{dt} = \lim_{\Delta t \to 0} \frac{x(t+\Delta t) - x(t)}{\Delta t}$
- $v = \frac{dx}{dt}$
- $a = \frac{dv}{dt}$



Equações do movimento

- $F = ma = m\frac{dv}{dt}$
- Sistema de equações:
  - $\frac{dv}{dt} = -g - \frac{\gamma}{m}v$
  - $v = \frac{dx}{dt}$

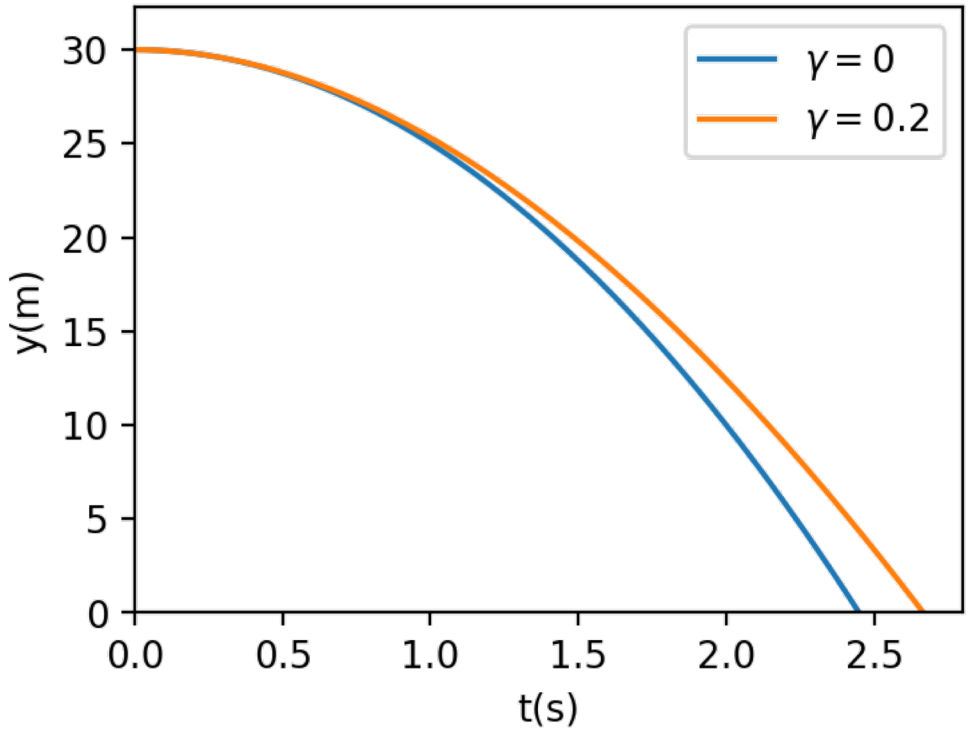
Método de Euler

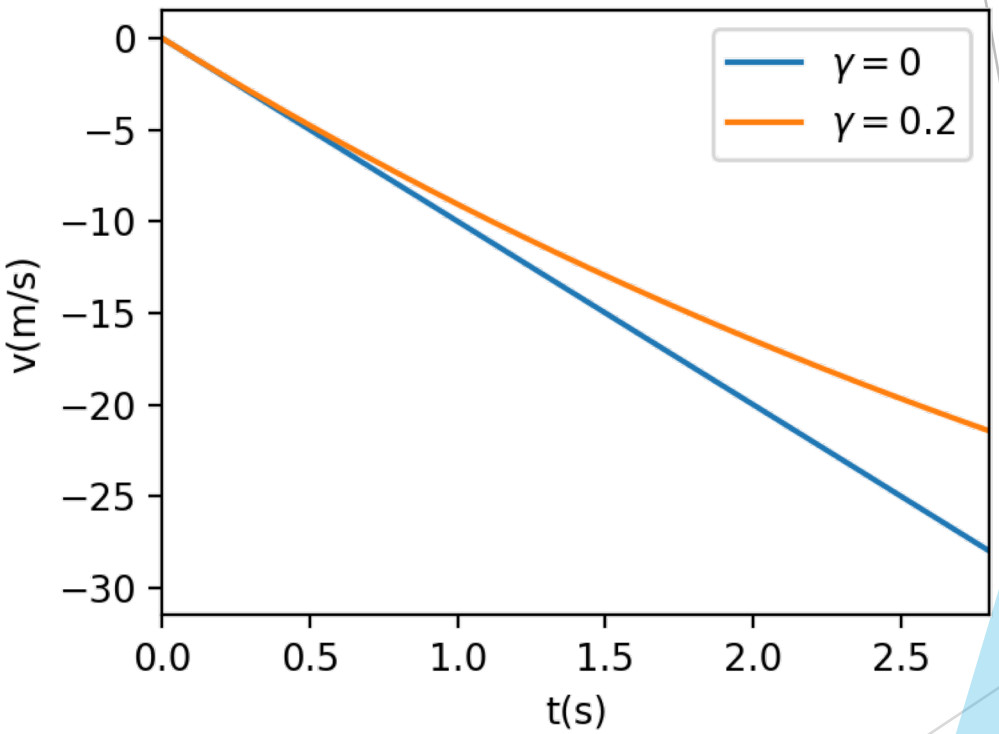
- $v = \frac{x(t+\Delta t)-x(t)}{\Delta t} \Leftrightarrow x(t+\Delta t) = v\Delta t + x(t)$
- $a = \frac{v(t+\Delta t)-v(t)}{\Delta t} \Leftrightarrow v(t+\Delta t) = a\Delta t + v(t)$

- $x[i] = v[i-1]\Delta t + x[i-1]$
- $v[i] = a[i-1]\Delta t + v[i-1]$

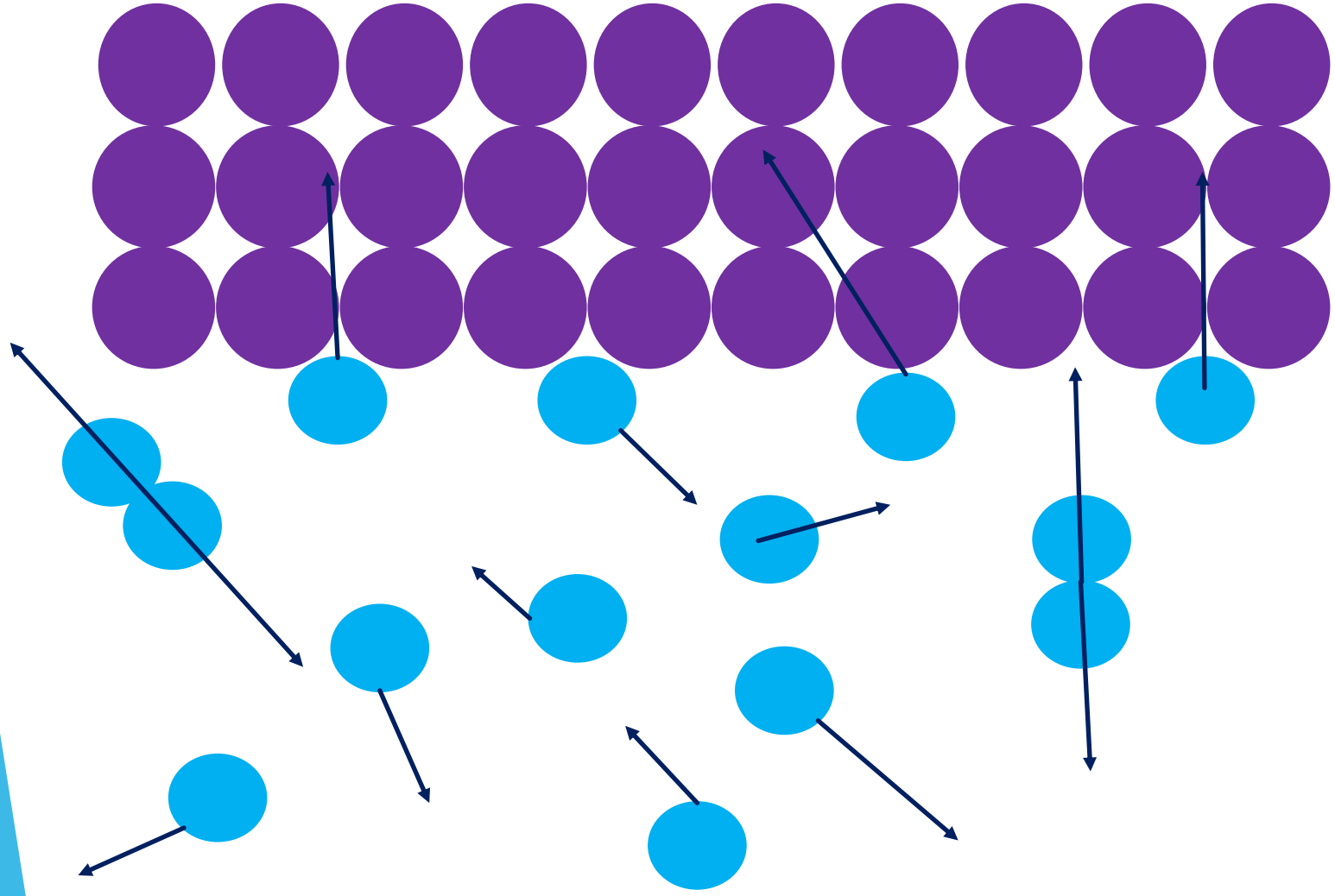
```
x0=0
v0= 0
g = 10
b = 2.0
m=6
t0=0
tf=2.
dt=0.0001

N=int((tf-t0)/dt)

x= np.zeros(N)
x[0]= x0

v = np.zeros(N)
v[0]= v0

t=np.zeros(N)
t[0]= t0

for i in range(1,N):
    x[i]= x[i-1] + v[i-1]*dt
    v[i]= v[i-1] + (-g-b*v[i-1])*dt
    t[i]= t0 + dt*i
```

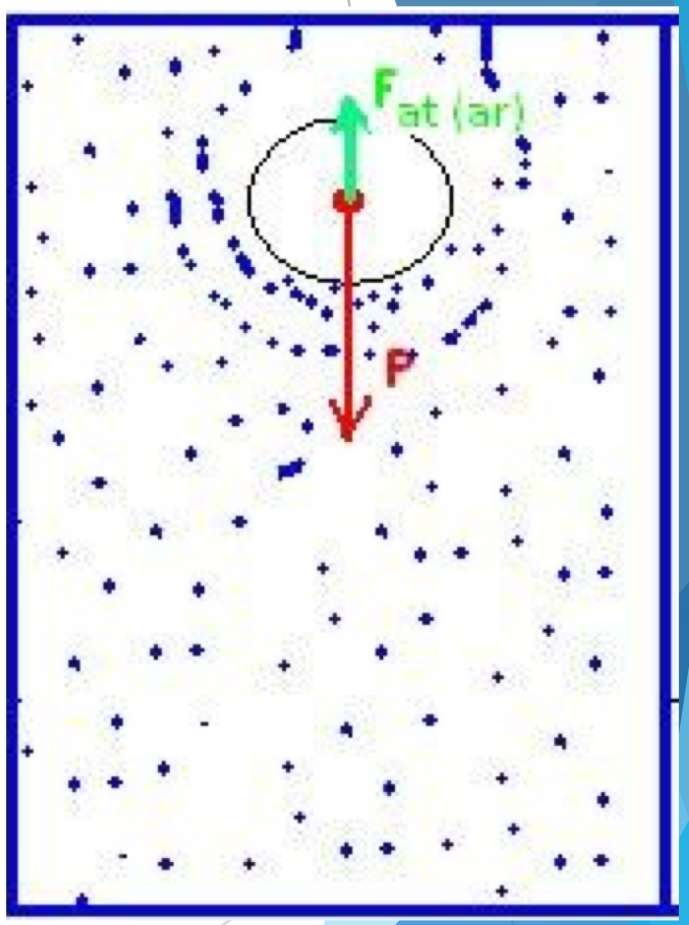
Método de Euler





O atrito a nível microscópico





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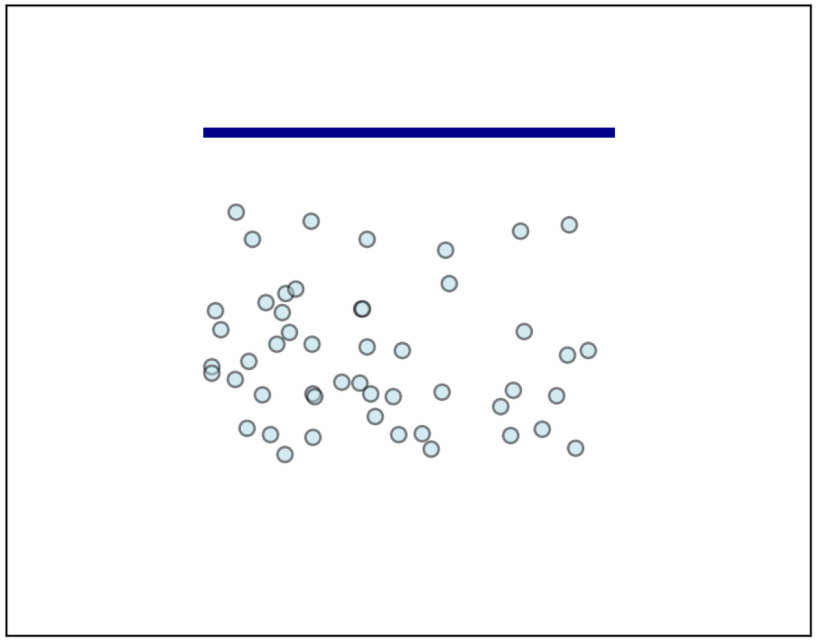

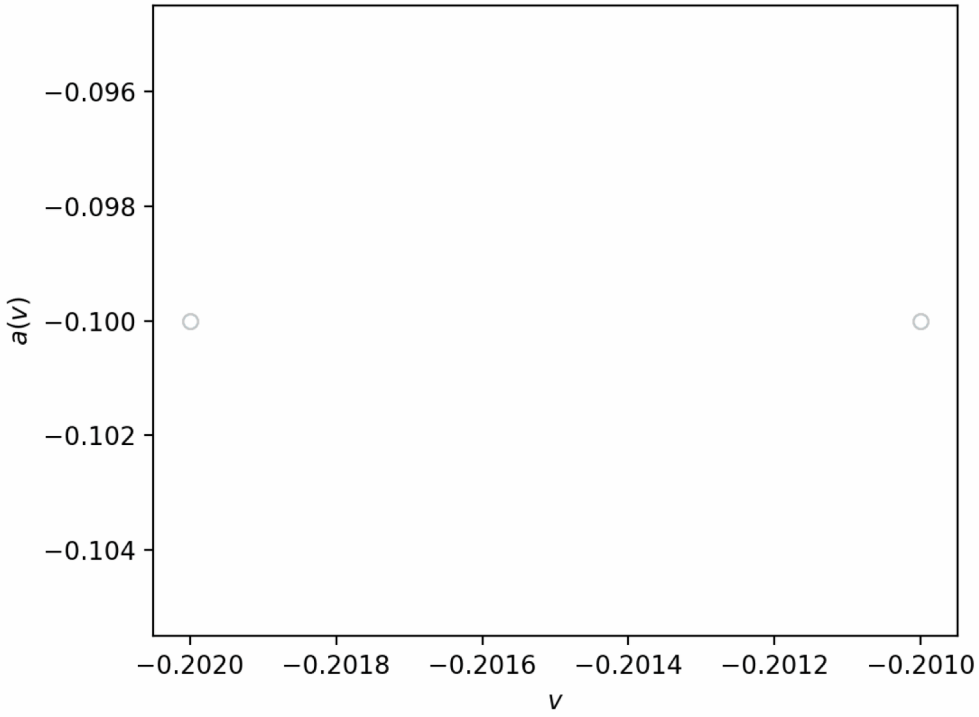

Conclusões

- A força de atrito é dependente da velocidade
- Existem problemas na física que podem ser resolvidos utilizando simulações
- A força de atrito pode ser explicada pelas colisões entre as partículas do ar e o objeto.