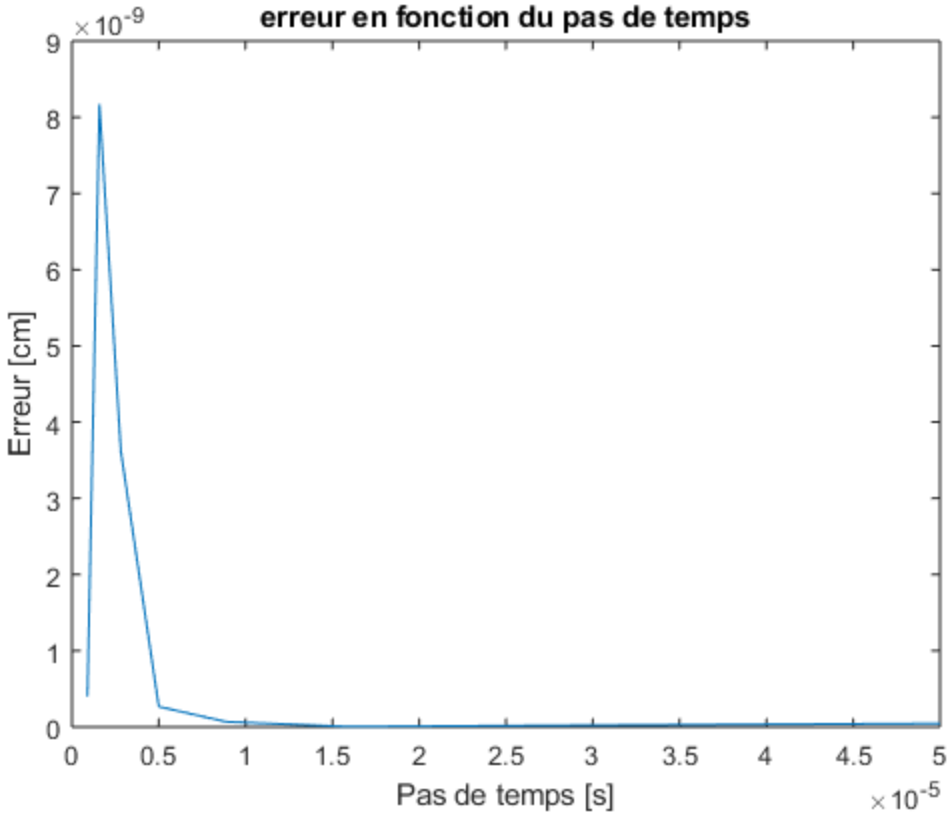
```
type calculetY
type calculetAllY


function [ y ] = calculetY( dt,yi_1,yi_2,k,m,alpha,g)
%This function calculates one itération of the y_i values


y=((2*m/dt^2 - k)*yi_1 + ((alpha/2 - m/dt)/dt)*yi_2 - m*g) *  (dt/
( alpha/2 + m/dt));


end


function [y,time] =
 calculetAllY( y,time,y0,v0,dt,T,k,m,alpha,g,timeMultiplier)
% This function thought all dt's and defines a y and tie vector for
 all of
% them.


for i1 = 1:length(dt)
        t=(0:dt(i1):timeMultiplier*T);
        time{i1}=t;
        y{i1}=zeros(length(t),1);
        y{i1}(1)=y0;
        y{i1}(2)=(1-(k*dt(i1)^2)/(2*m))*y0 + dt(i1)*(1-(alpha*dt(i1)/
(2*m)))*v0 - (g*dt(i1)^2)/2 ;
        for i2= 3:length(t)
            y{i1}(i2) = calculetY( dt(i1),y{i1}(i2-1),y{i1}
(i2-2),k,m,alpha,g);
        end
    end
```

question iii

```
clear all
clc
%initialisation

y0 = -3e-2; %-1e-2;
v0 = -1e-2; %-1.5e-2;
alpha = 0.15; %0.12;

k = 20;
g = 9.8;
m = 50e-3;
T = 2*pi*sqrt(m/k);
dt= transpose(10.^((-4.75):(0.25):(-3))*T/pi);
```

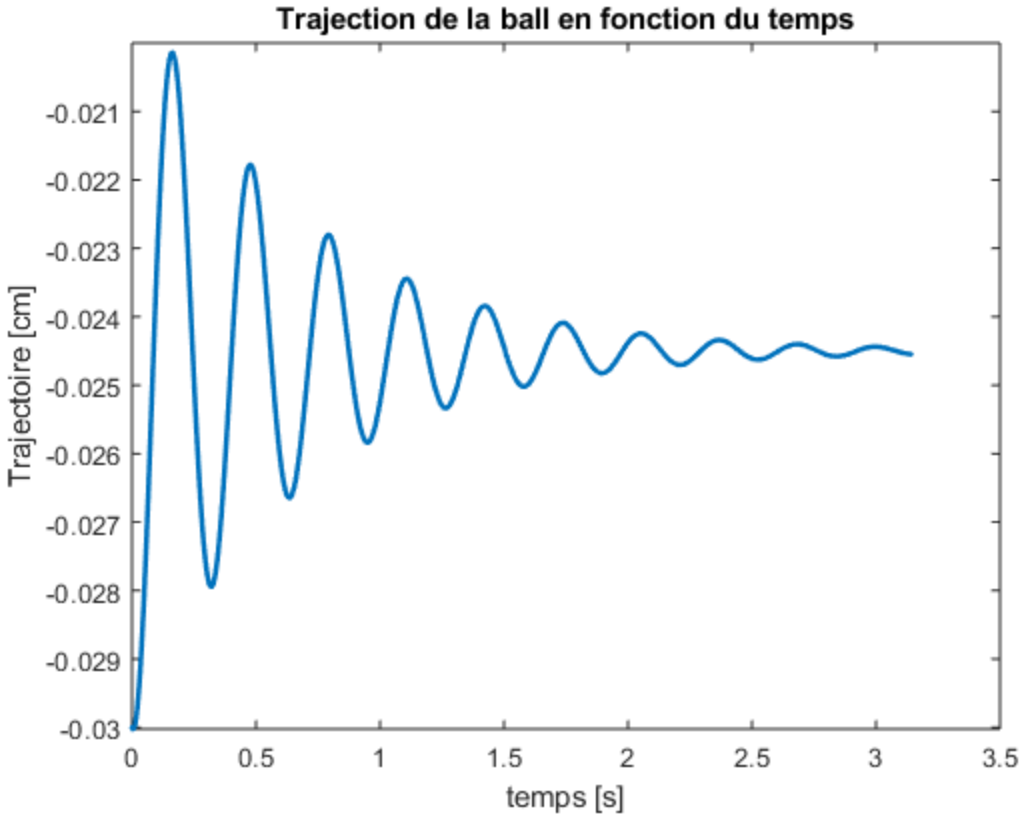
```
y = {};
time={};
dmax=zeros(8,1);
timeMultiplier = 0.6;

for n = 1:2 %Itère pour dt et dt/2
    dt = dt/n;

    [y,time] =
 calculetAllY(y,time,y0,v0,dt,T,k,m,alpha,g,timeMultiplier);

    for i3=1:1:length(y)
        dmax(i3)= max(abs(y{i3}-y0));

%         figure(i3)
%         plot(time{i3}(:),y{i3}(:),'.')
%         titl = sprintf('Pas de temps dt = %d',dt(i3));
%         title(titl);
    end
    if n==1
        dmax1 = dmax;
    else
        err = abs(dmax1-dmax);
    end
end

plot(dt,err)
title('erreur en fonction du pas de temps')
xlabel('Pas de temps [s]')
ylabel('Erreur [cm]')

% table(dt*2,dmax1,err)
fprintf('Pas de temps |Distance max(cm) |Erreur(cm) \n')
for i = 1:length(dt)
    fprintf('%d |%.9f      |%d \n',dt(i)*2,dmax1(i)*1e2,err(i)*1e2)
end

fprintf('L''erreur minimale est 5.229393e-10 cm \n')
fprintf('La distance maximale est 0.986030307 cm \n')
fprintf('Le pas de temps correspondant est: 3.162278e-05 \n')
```

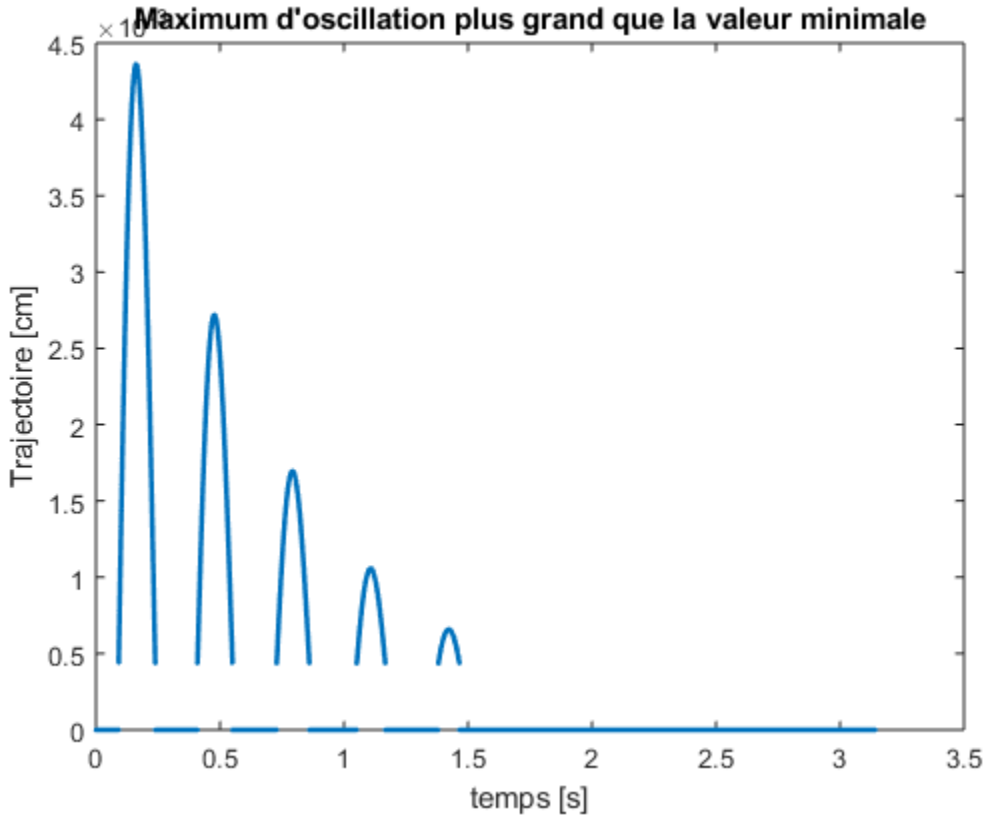
```
Pas de temps |Distance max(cm) |Erreur(cm)
1.778279e-06 |0.986029956      |4.014804e-08
3.162278e-06 |0.986030114      |8.172655e-07
5.623413e-06 |0.986030216      |3.625372e-07
1.000000e-05 |0.986030331      |2.670606e-08
1.778279e-05 |0.986030299      |6.804159e-09
3.162278e-05 |0.986030307      |5.229393e-10
5.623413e-05 |0.986030297      |2.071414e-09
1.000000e-04 |0.986030270      |4.613357e-09
L'erreur minimale est 5.229393e-10 cm
La distance maximale est 0.986030307 cm
Le pas de temps correspondant est: 3.162278e-05
```



Question iv

```
dt = 1e-3 *T/pi;
yeq = -m*g/k;
timeMultiplier = 10;
y = {};
time={};
[y,time] = calculetAllY(y,time,y0,v0,dt,T,k,m,alpha,g,timeMultiplier);

cut_function = (y{1}-yeq) .*( (y{1}-yeq)> max((y{1}-yeq)/10)  );
N_osc = length(findpeaks(cut_function));
figure()
plot(time{1}(:),y{1}(:),'.')
title('Trajection de la ball en fonction du temps')
xlabel('temps [s]')
ylabel('Trajectoire [cm]')

figure()
plot(time{1}(:),cut_function,'.')
title('Maximum d''oscillation plus grand que la valeur minimale')
xlabel('temps [s]')
ylabel('Trajectoire [cm]')
fprintf('Le nombre d''oscillation est %d \n',N_osc)

Le nombre d'oscillation est 5
```


Trajection de la ball en fonction du temps
Trajectoire [cm]
-0.021
-0.022
-0.023
-0.024
-0.025
-0.026
-0.027
-0.028
-0.029
-0.03
0
0.5
1
1.5
2
2.5
3
3.5
temps [s]


Maximum d'oscillation plus grand que la valeur minimale
×10^-3
Trajectoire [cm]
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
0.5
1
1.5
2
2.5
3
3.5
temps [s]

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